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ATOKAN (LATE BASHKIRIAN OR EARLY MOSCOVIAN) BRACHIOPODS FROM THE HARE FIORD FORMATION OF ELLESMERE ISLAND, CANADIAN ARCTIC ARCHIPELAGO

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Abstract

The Atokan (late Bashkirian or early Moscovian) brachiopod fauna from the lowermost Hare Fiord Formation in northern Ellesmere Island consists of at least 62 species, of which 18 are new, in at least 53 genera, of which three are new. New genera are the productoid *Lazarevia*, type species *L. stepanowensis* n. sp., the stenoscismatoid *Careoseptum*, type species *C. septentrionalis* n. sp., and an externally similar rhynchonelloid, *Exlaminella*, type species *E. insolita* n. sp. Other new species include *Orthotichia dorsistrigis*, *Plicatiferina kalashnikovi*, *Rugivestis pristina*, *Maemia gelida*, *?Fimbrinia borealis*, *Liraria paucispina*, *?Elassonia sverdrupensis*, *Antronaria annosa*, *Camarium nuperum*, *Nucleospira aquilonaris*, *Tiramnia walteri*, *Tiramnia grunti*, *?Heteraria canadiensis*, *Elinoria ellesmerensis*, *Parachoristites tellevakensis*, and *Cranaena nassichuki*. This diverse fauna bears clear northern European Russian affinities, as do similar-age faunas from the northern Yukon Territory and southeastern Alaska. This suggests that there was an open seaway which allowed free faunal dispersion and communication between northern European Russia to the east and also with the northern Yukon Territory and the southeastern Alaska Alexander Terrane to the southwest.

Key words: brachiopods, Carboniferous, Arctic, Ellesmere Island, Hare Fiord Formation

Introduction

The brachiopod fauna that is the subject of this paper was recovered from fenestellid bryozoan reefs at the base of the Hare Fiord Formation on both the north and south sides of Hare Fiord, northern Ellesmere Island. Although Carter (in Nassichuk, 1975) identified Carboniferous brachiopods from the Otto Fiord Formation from directly beneath the Hare Fiord Formation, the present paper constitutes the first description of Carboniferous brachiopods from Ellesmere Island and the first description of Upper Carboniferous brachiopods from the Canadian Arctic Archipelago.

The Hare Fiord Formation was named by Thorsteinsson (1970) for a succession of limestone, siltstone, and shale up to 732 m (2400 ft) thick within the Sverdrup Basin. This basin was formed by rifting of the Precambrian and Lower Paleozoic rocks of the Franklinian Geosyncline and contains approximately 14 km of upper Paleozoic through Cenozoic siliciclastic, carbonate, and evaporitic sediment. The Sverdrup Basin sequence rests unconformably on lower Paleozoic basement rocks of the Franklinian Geosyncline. The Hare Fiord Formation was deposited near

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the center of the basin along its northeast–southwest axis that passes through northern Ellesmere Island. It is overlain by black shale, siltstone, and bedded chert of the Permian Van Hauen Formation and underlain by medium-bedded anhydrite, limestone, and shale of the Bashkirian Otto Fiord Formation.

In much of its outcrop region the Hare Fiord Formation consists of two distinctive parts, a lower biogenic limestone that ranges in thickness from a few tens of meters up to 345 m and an upper unit of limestone, siltstone, and shale. The lower reefoid part was informally designated the "Tellevak Limestone" in the Blue Mountains area south of Hare Fiord by Bonham-Carter (1966). Although the brachiopod fauna within this lower biohermal unit is rich and diverse, brachiopods are rare above it and appear to be of limited biostratigraphic value.

Carboniferous brachiopods in the vicinity of or north of the Arctic Circle in North America are poorly known. Waterhouse, in Bamber and Waterhouse (1971), listed and illustrated Carboniferous and Permian brachiopod faunas from the northern Yukon Territory. Gorveatt and Nelson (1975) later described several Carboniferous and Permian spiriferids from this same region. Waterhouse and Waddington (1982) described both Carboniferous and Permian spiriferellid brachiopods from the Yukon Territory and the Canadian Arctic Archipelago. Carter (1975*a*) described two small faunules believed to be of late Early Carboniferous age from Melville and Axel Heiberg islands. Carter (1975*b*) listed but did not illustrate brachiopods from the Otto Fiord Formation of Melville and Ellesmere islands. Bowsher and Dutro (1957) and Dutro (1987) listed Carboniferous brachiopods from the Lisburne Group of northern Alaska but did not illustrate them.

Because there are many genera in the lower Hare Fiord Formation that range into the Permian and because one of the described Permian faunas was originally ascribed to the Carboniferous, citations of published reports dealing with Permian brachiopod faunas follow. These include Holtedahl (1917), Axel Heiberg Island; Chernyshev and Stepanov (1916), Ellesmere Island (originally described as Carboniferous); Harker and Thorsteinsson (1960), Devon Island; Stehli and Grant (1971), Axel Heiberg Island; and Waterhouse and Waddington (1982), various Arctic islands. All of these described Permian faunas are relatively small with moderate diversity.

Faunal Composition

Late Paleozoic carbonate buildups commonly bear diverse invertebrate faunas, especially rich in lophophorates, and this is true for the "Tellevak Limestone" in the Blue Mountains and other smaller bioherms elsewhere in the lower part of the Hare Fiord Formation. Several of the collections studied here were made from the flanks of bryozoan mounds or "reefs" as described in Davies et al. (1989) and Nassichuk and Davies (1992). From essentially three rich collections we have discriminated over 60 species of articulate brachiopods, many of which are represented by very few specimens making certain identification difficult or impossible. The bulk of the species occur in a single collection from which Nassichuk (1975) described 15 species of Atokan ammonoids (GSC locality 56430). The level of brachiopod diversity in this collection approaches that in many of the individual collections seen in Cooper and Grant's (1972–1976) monumental monograph on the rich pre-Tethyan Permian silicified faunas of west Texas, which was based on massive samples. Sampling efficiency is usually vastly greater for large silicified samples than for most "crackout" collections.

Table 1.—*Summary table showing the taxonomic composition of the brachiopod fauna of the lower Hare Fiord Formation.*

Group	Families	Genera	Species
Orthids	2	2	3
Orthotetids	1	1	1
Chonetids	2	2	2
Productids	8	20	21
Rhynchonellids	5	7	7
Pentamerids	2	2	2
Athyridids	2	2	2
Spiriferids	8	15	19
Retziids	1	1	1
Terebratulids	2	2	4

Because the genus is the basic taxonomic unit used in comparing brachiopods from widely separated basins or continents, only generic diversity of the Hare Fiord brachiopods is discussed below. Productids, rhynchonellids, and spiriferids make up the bulk of this fauna, as can be seen in Table 1, with several notable omissions or poor representations. For example, we found no inarticulates, few chonetids, only scraps of orthotetids, and but two unusual athyridid species.

For some of these genera the level of confidence in the generic-level identification is low because of the lack of interiors. This should be borne in mind when assessing Tables 1 and 2. Even if several of the identifications are incorrect, there is clearly an impressive number of both older and younger anachronisms in this biohermal fauna.

Orthids.—Two orthid genera, *Rhipidomella* and *Orthotichia*, are found in the lower part of the Hare Fiord Formation. The former, a very long-ranging genus, is not recognizable to the species level and cannot be compared with other North American species. The genus *Orthotichia* is represented in the lower Hare Fiord Formation by two species, including a new one, *O. dorsistrigis*. This genus is confined to Upper Carboniferous and Permian strata, first appearing in the late Bashkirian or early Moscovian. Only three species are known from the North American Upper Carboniferous: *O. schuchertensis* Girty, from the Belden Shale of Colorado and probably of Morrowan (Bashkirian) age according to Langen-

Table 2.—*Ranges of lower Hare Fiord Formation anachronistic brachiopod genera. Possible misidentifications are marked with a (?).*

Genus	Prior range	New range
Camarium	Silurian–Tournaisian	Silurian–Lower Moscovian
Retimarginifera (?)	Sakmarian–Kungurian	Lower Moscovian–Kungurian
Maemia	Late Moscovian	Lower Bashkirian–Upper Moscovian
Eomarginifera	Viséan	Viséan–Lower Moscovian
Eomarginiferina	Viséan	Viséan–Lower Moscovian
Fimbrinia (?)	Kasimovian	Lower Moscovian–Kasimovian
Pustula	Tournaisian–Serpukhovian	Tournaisian–Lower Moscovian
Liraria	Kungurian	Lower Moscovian–Kungurian
Fluctuaria	Viséan–Serpukhovian	Viséan–Lower Moscovian
Cenorhynchia	Asselian–Kazanian	Lower Moscovian–Kazanian
Hemileurus (?)	Asselian	Lower Moscovian–Asselian
Antronaria	Sakmarian–Artinskian	Lower Moscovian–Artinskian

heim (1991); *O. morganiana* Derby, from Desmoinesian beds in Nevada as reported by Langenheim (1991); and *O. nawtawaketensis* Watkins, 1974, from the Baird Formation of California and of Bashkirian or Moscovian age. Several Russian species have been described from the Bashkirian through lower Permian and their morphology and distribution are summarized by Lazarev (1976).

Orthotetids.—This group, common in the upper Carboniferous (Pennnsylvanian) of the midcontinental portion of North America, is represented in the lower Hare Fiord fauna only by unidentifiable fragments.

Chonetids.—This is another poorly represented group in the lower Hare Fiord fauna. Only two genera were identified, *Chonetinella* and *Sokolskya*. The former ranges from Bashkirian to Kungurian and the latter ranges from Bashkirian to Kasimovian. In most of North America the two most common Atokan and Desmoinesian chonetoid genera are *Mesolobus* and *Neochonetes*, both of which are missing from Ellesmere Island collections.

Productids.—The productids are the most diverse group in this fauna with 21 species in 20 genera. They, along with the spiriferids and rhynchonelloids, make up the bulk of the Hare Fiord brachiopod fauna. The most common productids in the North American midcontinent are cosmopolitan genera such as *Antiquatonia*, *Linoproductus*, *Cancrinella*, *Kozlowskia*, and *Echinaria*, all represented in the Hare Fiord fauna.

The suborder Strophalosiidina is represented by only one genus, *Plicatiferina*. This genus also occurs in the Upper Bashkirian to Lower Moscovian of southeastern Alaska. In Russia, it ranges from the upper Moscovian into the Lower Permian.

Within the superfamily Productoidea the family Productellidae includes in the lower Hare Fiord the genera *Rugivestis*, *Krotovia*, *Lazarevia*, *Maemia*, and possibly *Eomarginiferina*, *Fimbrinia*, *Hystriculina*, and *Retimarginifera*. *Rugivestis* was described from the Permian of Oregon and also is known from the lower Moscovian through Lower Permian of Russia and Lower Permian of China. The Hare Fiord species is also found in the late Bashkirian or early Moscovian Ladrones Limestone of southeastern Alaska. *Krotovia* is most commonly reported from Viséan through Bashkirian strata but is rarely reported up through the Lower Permian. *Lazarevia* is a new monotypic genus. *Maemia* is otherwise known only from the late Moscovian of Cape Chaika, northern Russia. Lacking interiors the identity of the specimens identified as *Eomarginiferina* is not certain. That genus is previously known only from the Upper Viséan of Ireland. *Fimbrinia* previously ranged from the late Kazimovian into the middle Permian. *Hystriculina* normally ranges from the Kazimovian through the Sakmarian. *Retimarginifera* is a Permian genus. The family Productidae includes the genera *Reticulatia*, *Eomarginifera*, *Kutorginella*, and possibly *Kozlowskia*. *Reticulatia* is a cosmopolitan genus ranging from the Bashkirian through the Lower Permian. *Eomarginifera* is a Viséan European genus. The genus *Kutorginella* was described from the Moscovian of the Russian platform but it is also known from several species in Russia and North America ranging in age from Sepukhovian through Kungurian. In western Europe *Antiquatonia* is known only from the Lower Carboniferous but has been reported from the Upper Carboniferous as well as the Lower Carboniferous of Kazakhstan. In North America this genus first appears in the latest Mississippian and ranges upward into the Lower Permian. *Kozlowskia* is another cosmopolitan genus ranging from the Bashkirian through the Lower Permian.

The superfamily Echinoconchoidea is represented by the genera *Pustula* and

Echinaria. *Pustula* is used here in the broad sense because no interiors are known for these Arctic specimens. True *Pustula* is probably restricted to the Lower Carboniferous but the name is applied here to pustulose nonrugose specimens with rounded outlines. Their actual affinities are unknown. *Echinaria* ranges throughout most of the Upper Carboniferous. Winkler Prins (1968) reported this genus from the lower Moscovian of northern Spain.

The superfamily Linoproductoidea is represented by three genera. *Liraria* was previously known only from the Kungurian of Texas. An undescribed species also occurs in the upper Bashkirian or lower Moscovian of southeastern Alaska. *Fluctuaria* was previously restricted to the Viséan and possibly Serpukhovian of Eurasia. Kos'ko et al. (1993) reported it from the middle Bashkirian of Wrangel Island, Winkler Prins (1968) reported it from the upper Moscovian of northern Spain, and Kalashnikov (1980) reported it from the late Upper Carboniferous of Novaya Zemlya. *Cancrinella* ranges throughout most of the Upper Carboniferous and Permian. Reports from the Bashkirian and Moscovian are less common than from the Kasimovian and above. These small, fragile shells never seem to occur in abundance but have a remarkably wide distribution.

Rhynchonellids.—There are seven genera of rhynchonelloids in this fauna including *Cenorhynchia*, ?*Elassonia*, ?*Phrenophoria*, ?*Hemileurus*, *Septacamera*, and *Antronaria* plus the new genus *Exlaminella*. All of these genera except the latter have Permian type species and only *Septacamera* occurs in the Carboniferous, where it ranges down into the Bashkirian. Rhynchonellids in the Upper Carboniferous of the midcontinent are not generically diverse, mostly belonging to the genera *Wellerella*, *Leiorhynchoidea*, and the punctate genus *Rhynchopora*, none of which occur in this fauna. The undescribed late Bashkirian or early Moscovian rhynchonelloids from southeastern Alaska are also generically diverse judging from exteriors.

Stenoscismatoids.—Stenoscismatoids are represented by two genera, *Stenoscisma* and a new genus, *Careoseptum*. The former is cosmopolitan and long ranging. The latter is unique to the Hare Fiord Formation.

Athyridids.—There are two unusual athyridoids in this fauna, *Camarium* and *Nucleospira*. Whereas one would expect to find the cosmopolitan genera *Composita* and *Cleiothyridina* in any late Paleozoic fauna, they are absent here. Instead, the superfamily is represented by the above-named rare genera. *Camarium*, heretofore unknown above the Tournaisian (see Campbell and Engel, 1963, and Carter, 1967), greatly extends its stratigraphic range. *Nucleospira* is rare above the Viséan. Only two species of this genus are described from above the Viséan, one from the basal Morrowan and one from the Permian of west Texas.

Spiriferids.—With 19 species in 14 or 15 genera the spiriferids are nearly as diverse as the productids. There are two species of the ambocoelioid genus *Crurithyris*, five martinioids in three or four genera, seven species of spiriferoids in seven genera, (including four choristitids in four genera), two species of paeckelmanelloids of the genus *Cantabriella*, two species of the brachythyridoid *Meristorygma*, and one reticularioid. The choristitids and martinioids indicate strong affinities with northern Russian faunas. Few of these spiriferid genera have a narrowly restricted stratigraphic distribution. Most of them range throughout the Upper Carboniferous and Lower Permian. However, the paeckelmanelloid genus *Cantabriella* is previously known only from the Bashkirian and Moscovian of northern Spain.

Crurithyris ranges throughout the entire Carboniferous and most of the Permian. The martinioid genera *Tiramnia*, *Heteraria*, and *Jilinmartinia* occur in this fauna. Specimens of *Tiramnia* occur abundantly in most of the collections. This genus was originally described from the Upper Carboniferous and Permian of Taimyr, Novaya Zemlya, Timan, Ural Mountains, and Greenland. Besides this new occurrence in the Canadian Arctic Archipelago, this genus occurs in rocks of the same age in southeastern Alaska. *Heteraria* was described from the Permian of west Texas. It also occurs in the lower Moscovian of southeastern Alaska. *Jilinmartinia* is based on a Late Carboniferous species from northern China and also occurs in the Kasimovian of Bashkiria. A single small martinioid specimen of unusual proportions probably represents a new genus and species.

The spiriferoids are the most diverse superfamily of this order and include the genus *Anthracospirifer* of the family Spiriferidae. The family Choristitidae includes *Elinoria* and *Brachythyrina* of the subfamily Angiospiriferinae, *Parachoristites* and *Trautscholdia* of the subfamily Choristitinae, and *Tangshanella* of the subfamily Tangshanellinae. The trigonotretids are represented only by the genus *Gypospirifer* of the subfamily Neospiriferinae.

Anthracospirifer is a widespread North American Carboniferous spiriferid ranging from the lower Viséan (Keokuk) through the Moscovian (Desmoinesian). This genus is rare in Russia and its presence in the Hare Fiord Formation indicates North American faunal affinities. *Elinoria* is found in the upper Moscovian, Late Carboniferous, and Lower Permian of European Russia and the Donets Basin. It also is present in the lower Moscovian of southeastern Alaska as well as the Hare Fiord Formation. These North American occurrences extend the range down to the early Moscovian. *Brachythyrina* is rare in North America being reported from the very late Mississippian of Wyoming and the Bashkirian or Moscovian (Ettrain Formation) of Yukon Territory. The genus ranges throughout most of the late Paleozoic of Eurasia. *Parachoristites* is characteristic of the Bashkirian of Russia but ranges up into the Lower Permian. This is the first report of the genus from North America. *Trautscholdia* ranges throughout the entire Upper Carboniferous of Russia. Again, this is the first report of this genus in North America. *Tangshanella* was first described from the Upper Carboniferous of northeastern China and has subsequently been reported from the Tournaisian of Australia and the Upper Carboniferous of northwestern China and Japan. The neospiriferid *Gypospirifer* ranges from the Bashkirian into the Lower Permian and appears to have cosmopolitan distribution.

Retziids.—The retzioid genus *Hustedia* ranges throughout the late Paleozoic and is cosmopolitan.

Terebratulids.—Terebratulids generally are of little use in late Paleozoic age determination, the genera usually being long ranging. *Beecheria* appears in the Tournaisian and ranges into the Lower Permian. *Cranaena* is rarely reported in the Upper Carboniferous. It has been reported from the Devonian to the Lower Permian, although many of these reports have not been confirmed with interior morphological details.

Biostratigraphy

The Atokan (late Bashkirian or early Moscovian) age assigned to this brachiopod fauna is based on direct and indirect ammonoid, conodont, and foraminifer evidence. Nassichuk (1975) described a large ammonoid fauna from a reef on the north side of Hare Fiord (GSC locality 56430) ascribing an Atokan (or early

Moscovian) age to it. Conodont data published by Bender (1980) supported the early Moscovian age. Nassichuk and Davies (1992) suggested that the Atokan included late Bashkirian as well as early Moscovian strata. Newly discovered conodonts from GSC locality 56430 are being studied by T. Nemirovskaya and N. Sobolev who also have ascribed a late Bashkirian to early Moscovian age to the Hare Fiord.

Diagnostic foraminifers have been recovered from the lower Hare Fiord Formation by Mamet (in Nassichuk, 1975) who suggested an early Moscovian age. Groves et al. (1994) also correlated the Atokan with the late Bashkirian and early Moscovian and recovered both late Bashkirian and early Moscovian fusulinaceans from the coeval Nansen Formation.

The brachiopods, including taxa formerly ascribed to Viséan through Lower Permian stratigraphic ranges, are of much less utility in age determination. The presence of numerous genera which also have been reported in early Moscovian beds in the European portion of Russia, however, generally supports this age determination.

Anachronisms

Table 2 lists the genera which previously had substantially different stratigraphic ranges. Note that there are 12 genera of possible anachronisms, six younger and six older. Misidentifications might reduce this number but it is clear that the Hare Fiord brachiopod fauna represents an unusual upper Bashkirian to lower Moscovian biohermal biofacies unknown elsewhere. These anachronisms originally led us to assign a lower Permian age to the fauna on the assumption that the youngest faunal elements gave some indication of the true age of the fauna. The overwhelming evidence from the ammonoids and microfossils of an upper Bashkirian to lower Moscovian age of the lower Hare Fiord Formation forced us to reexamine and revise our preliminary taxonomic and biostratigraphic determinations.

Correlations and Paleobiogeography

Although the lower Hare Fiord Formation fauna described herein cannot be correlated directly with previously described brachiopod faunas of similar age from North America, it bears many similarities with the undescribed allochthonous faunas from the Ladrones Limestone and Klawak Formation of southeastern Alaska, Alexander Terrane. These coeval formations bear rich brachiopod faunas containing a number of distinctive Hare Fiord brachiopod genera that do not occur elsewhere in Bashkirian or Moscovian strata in North America, with the possible exception of the Yukon Territory. These include *Plicatiferina*, *Rugivestis*, *Fluctuaria*, *Liraria*, *Elinoria*, *Tiramnia*, *Gypospirifer*, *Meristorygma*, *Brachythyrina*, and *Heteraria*.

These diverse assemblages certainly provide a strong biogeographic link to the Ellesmere Island fauna of approximately the same age and suggest that they were connected by an unrestricted, if indirect, seaway. The exact location of this seaway is speculative but could have passed through the present Yukon Territory or perhaps through northeastern Alaska, both of which are known to bear largely undescribed early Moscovian (Atokan) faunas (Bamber and Waterhouse, 1971; Dutro, 1987).

Correlation with the remainder of North America, however, is much more difficult. Considering the present fauna, only *Kozlowskia splendens* (Norwood and Pratten), *Chonetinella* cf. *C. jeffordsi* Stevens, *Reticulatia* cf. *R. americana* Dunbar and Condra, *Antiquatonia* cf. *A. hermosana* (Girty), and *Anthracospirifer* cf. *A. occiduus* Sadlick suggest a Pennsylvanian age, ranging from Atokan to Virgilian.

Several Moscovian species were illustrated or listed from the Upper Carboniferous of northern Yukon Territory by Bamber and Waterhouse (1971) and Gorveatt and Nelson (1975). Most of these species were later assigned a late Moscovian age by Waterhouse and Waddington (1982). Two small faunules designated as the "*Martiniopsis*" Zone and the *Buxtonia* Zone, however, were later assigned to the early Moscovian by Waterhouse and Waddington (1982). None of the species listed or illustrated show much similarity to those of the Ellesmere Island fauna but the presence of so-called *Choristites* and "*Martiniopsis*" in the Yukon collections suggest Russian affinities. In the late Moscovian faunas the presence of *Waagenoconcha* and abundant *Choristites* suggest the same affinities. The spiriferids described by Gorveatt and Nelson (1975) were dated as late Moscovian and also clearly indicate Russian affinities.

In summary, the faunas from limestone reefs in the lower part of the Hare Fiord Formation, from the Ettrain Formation of northern Yukon Territory, and from the Ladrones Limestone and Klawak Formation of southeastern Alaska all have strong affinities with those of northern European Russia and with each other. The faunas from the Alexander Terrane of southeastern Alaska may be allochthonous but the close similarity between those faunas and those from the lower Hare Fiord clearly suggest an open marine communication between the two regions.

Correlations with upper Bashkirian or lower Moscovian strata in northern European Russia is difficult, being dependent mainly on faunal lists. Kalashnikov (1980) reviewed late Paleozoic brachiopod faunas from this region and listed species for numerous localities and horizons in the general area encompassing Novaya Zemlya, Cape Chaika, Timan, and the northern Urals. However, most of his illustrations are of specimens from younger beds. The following genera from the lower Hare Fiord Formation are reported by Kalashnikov from Bashkirian or Lower Moscovian beds in northern Russia: *Rhipidomella*, *Eomarginifera*, *Rugivestis*, *Kozlowskia*, *Antiquatonia*, *Krotovia*, *Kutorginella*, *Reticulatia*, *Fimbrinia*, *Linoproductus*, *Fluctuaria*, *Septacamera*, *Parachoristites*, *Purdonella*, *Brachythyrina*, *Elinoria*, *Meristorygma*, *Phricodothyris*, *Cranaena*, and *Tiramnia* (Kalashnikov includes numerous references to various species of *Martinia*, some of which probably belong in *Tiramnia*). This assemblage is unique to northern Russia and Ellesmere Island but also includes many cognate genera in southeastern Alaska.

GSC LOCALITIES

Figure 1 shows Geological Survey of Canada (GSC) localities where late Bashkirian to early Moscovian brachiopods were found in the Hare Fiord Formation. Descriptions of these localities follow.

GSC Locality C-4083.—In the saddle of a northeast–southwest trending ridge about eight km northwest of Mount Barrell and immediately west of Wood Glacier (80°54′N, 84°11′W). The locality is in thin-bedded, dark grey limestone, about 46 m above the base of the Hare Fiord Formation. It is in the nonreef facies of

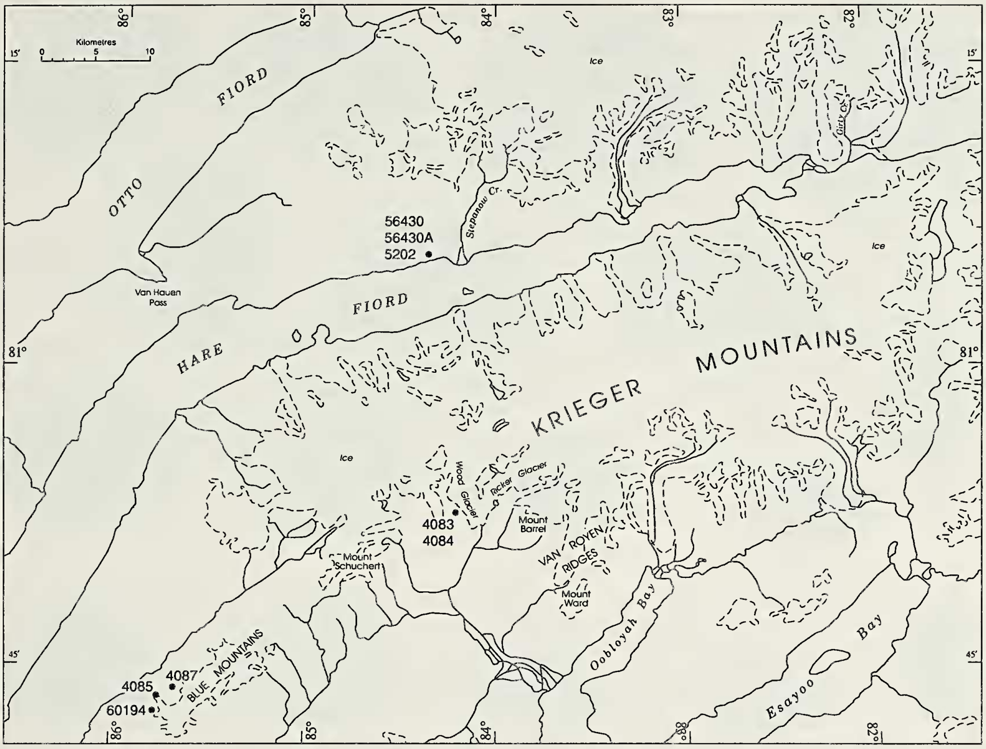


Fig. 1.—Index map showing Geological Survey of Canada (GSC) localities for the Upper Carboniferous brachiopods described in this report, from both the north and south sides of Hare Fiord, northern Ellesmere Island. Most of the fossils are from GSC locality 56430 in a small bryozoan bioherm on the north side of Hare Fiord. GSC locality 56430A is from the same stratigraphic level as GSC locality 56430 but is 3 m farther to the west. Similarly, GSC locality C-5202 is 1.5 m stratigraphically below locality 56430. GSC localities C-4083 and C-4084 are in thin argillaceous limestone some 45.72 m (150 ft) above the base of the Hare Fiord Formation west of Wood Glacier; GSC locality C-4084 is 60.96 m (200 ft) along strike to the west of GSC locality C-4083. GSC localities C-4087, C-4085, and 60194 in the southern Blue Mountains occur in the upper part of a bryozoan reef complex that Bonham-Carter (1966) informally named the "Tellevak Limestone" in the lower Hare Fiord Formation. Dashed lines indicate boundary of permanent ice.

the formation and was discovered originally by W. W. Nassichuk and C. Spinosa (Boise State University) in 1969.

GSC Locality C-4084.—This locality is in the same stratigraphic position 61 m along strike to the west of GSC locality C-4083. This locality is in the nonreef, basinal facies of the Hare Fiord Formation.

GSC Locality C-4085.—This locality occurs in light grey skeletal limestone in the upper three m of the informally designated "Televak Limestone" in the Hare Fiord Formation. It is on the southwestern side of the Blue Mountains, 5.8 km northeast of the northern tip of Hare Fiord Diapir (80°44'N, 85°40'54"W). The locality is in a creek bottom near the terminus of the southernmost large westerly directed glacial tongue flowing from a small ice field in the southern Blue Mountains. This locality was discovered by W. W. Nassichuk and C. Spinosa (Boise State University) in 1969.

GSC Locality C-4087.—This locality is in the upper part of the "Tellevak

Limestone" in the lower Hare Fiord Formation on the northwest side of the Blue Mountains, 1.3 km east–northeast of GSC locality C-4085.

GSC Locality 56430.—Principal brachiopod locality. Near the top of a small bryozoan mound about 30 m above the base of the Hare Fiord Formation. This locality is less than 300 m north of the fiord and 3.2 km west of the midpoint of the delta formed by Stepanow Creek (81°07′30″N, 84°20′W). Collected by W. W. Nassichuk and various field associates in 1963, 1969, and 1971.

GSC Locality 56430A.—In the same stratigraphic position as GSC locality 56430 and within the same small bryozoan mound but three m farther to the west.

GSC Locality C-5202.—This is the same general location within the same bryozoan mound as GSC locality 56430, only 1.5 m stratigraphically lower.

GSC Locality 60194.—Upper part of the reefoid "Tellevak Limestone" in the lower Hare Fiord Formation. The locality is 174 m above the top of the underlying Otto Fiord Formation (Bashkirian) which contains mainly anhydrite, shale, and limestone. It is ten km east of eastern shore of Hare Fiord, southern Blue Mountains, northern Ellesmere Island (80°44′11″N, 85°45′40″W). Collected by G. F. Bonham-Carter (Geological Survey of Canada) in 1963.

SYSTEMATIC PALEONTOLOGY

In the following section we have used the relatively recent classifications of Brunton et al. (1995) for the productoids and Afanas'eva (1988) for the chonetoids. For the spiriferids we have used the revised classification of Carter et al. (1994). The rhynchonellid classification follows that of Savage (1996). For the other groups we have generally followed the classification in the original Treatise on Invertebrate Paleontology (Williams et al., 1965).

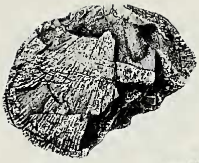
All types are deposited in the type collections of the Geological Survey of Canada, Ottawa. The remainder of the specimens are in the collections of the Institute of Sedimentary and Petroleum Geology, Calgary.

Phylum Brachiopoda Duméril, 1806
Class Articulata Huxley, 1869
Order Orthida Schuchert and Cooper, 1932
Suborder Orthidina Schuchert and Cooper, 1932
Superfamily Enteletoidea Waagen, 1884
Family Rhipidomellidae Schuchert, 1913
Genus *Rhipidomella* Oehlert, 1890
Rhipidomella sp.
(Fig. 2.1, 2.2)

Discussion.—There are two specimens of this genus in the collection from GSC locality 56430, plus one ventral valve from GSC locality 56430A. The large incomplete specimen is broad and thin bodied, similar in some respects to *Rhipidomella oweni* Hall and Clarke from the Lower Viséan of Kentucky or *Rhipi-*

→

Fig. 2.—Orthids. 2.1, 2.2, *Rhipidomella* sp., GSC 115535; dorsal and ventral views, × 1.5. 2.3–2.7, *Orthotechia* sp., GSC 115536; ventral, dorsal, lateral, anterior, and posterior views, × 1. 2.8–2.37, growth series of *Orthotechia dorsistrigis* n. sp., including the holotype (Fig. 2.8–2.12, GSC 115537) and five paratypes, GSC 115538–115542, respectively, × 1.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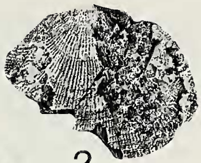
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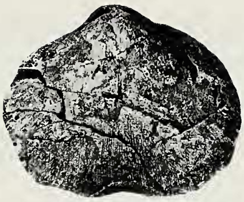
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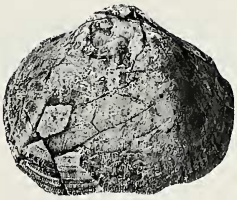
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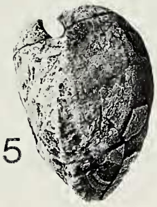
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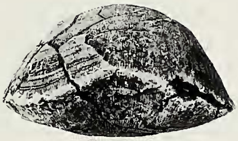
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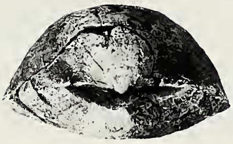
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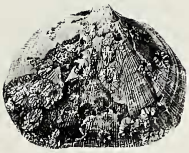
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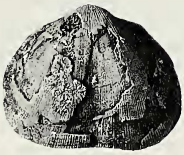
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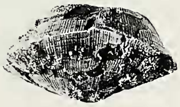
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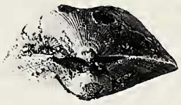
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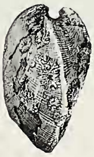
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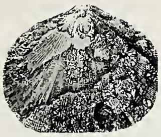
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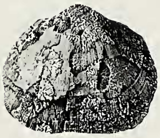
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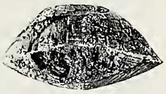
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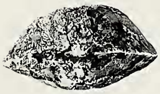
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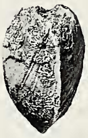
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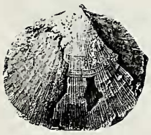
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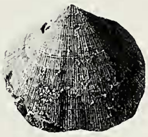
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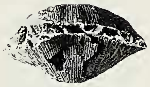
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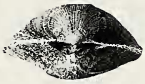
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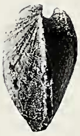
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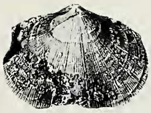
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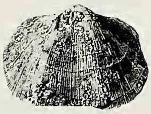
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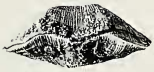
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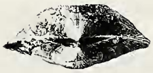
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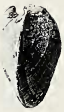
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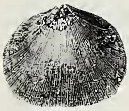
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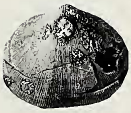
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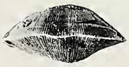
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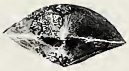
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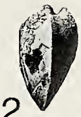
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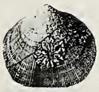
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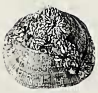
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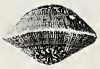
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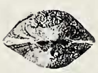
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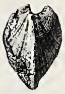
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Table 3.—*Measurements (in millimeters) of the types of* Orthotichia dorsistrigis *n. sp.*

GSC number	Locality	Length	Width	Thickness
115537	56430	19.5	24.1	13.0
115538	56430	17.2	21.2	11.4
115539	56430	16.9	19.0	10.4
115540	56430A	13.6	19.5	8.7
115541	56430	13.7	16.7	8.0
115542	56430	11.4	12.6	7.8

domella pressula Lazarev from the Moscovian of the polar Urals. The other specimens are much smaller but of similar proportions.

Family Enteletidae Waagen, 1884
Subfamily Schizophoriinae Schuchert, 1929
Genus *Orthotichia* Hall and Clarke, 1892
Orthotichia dorsistrigis, **new species**
(Fig. 2.8–2.37)

Holotype.—GSC 115537, Figures 2.8–2.12, from GSC locality 56430.

Paratypes.—GSC 115538, 115539, 115541, and 115542, Figures 2.13–2.22, 2.28–2.37, from GSC locality 56430; GSC 115540, Figures 2.23–2.27, from GSC locality 56430A.

Description.—Medium size, unequally biconvex; outline transversely subovate; dorsal valve equal to or slightly longer than ventral valve; maximum width attained slightly anterior to midlength; hingeline about equal to half of maximum width; anterior margin slightly emarginate and weakly uniplicate; ventral sulcus weakly developed; dorsum with distinct secondary sulcus on fold in anterior half or two-thirds of valve; lateral profile moderately thin, guttate; cardinal extremities of both valves slightly compressed; entire surfaces of valve regularly capillate.

Ventral valve slightly thinner than opposite valve, moderately to weakly convex with slightly inflated umbonal region; sulcus broad, shallow, confined to anterior half of valve, with low median fold in rare specimens; beak small, overhanging nearly catacline low, widely triangular interarea; delthyrium about as wide as high; ventral interior with long, high dental plates and low, thick median ridge; other details unknown.

Dorsal valve slightly to moderately thicker than ventral valve, most convex in umbonal region, flanks sloping evenly to lateral margins; umbonal region slightly inflated and projecting posterior to hingeline with small incurved beak; dorsum broadly depressed in most mature specimens forming shallow sulcus; dorsal interarea low, orthocline; dorsal interior with moderately thickened cardinal process and long, high, diverging brachiophore plates; other details unknown.

Measurements of Types.—See Table 3.

Diagnosis.—This species is characterized by its moderate size, transverse outline, thin profile, shallow broad ventral sulcus, and dorsal sulcus.

Comments.—*Orthotichia pentagona* (Eichwald, 1860), from the Bashkirian of Ukraine and Russia, is much larger than *O. dorsistrigis* n. sp. with a subpentagonal outline and stronger dorsal sulcus and ventral fold. A dorsal sulcus is also found in the specimen described as *Orthotichia*? sp. by Yanagida (1975), from the upper Moscovian of Thailand.

Distribution.—GSC locality 56430 (36 specimens); GSC locality C-5202 (five specimens).

Orthotichia sp.
(Fig. 2.3–2.7)

Comments.—There are two large orthotichias from GSC locality 60194 that are clearly distinct from the new species described above as *O. dorsosulcata* n.

sp. These large specimens lack the dorsal sulcus seen in that species. They appear to be similar to *Orthotichia schuchertensis* Girty, 1903, from the Hermosa Formation of Colorado, in having discontinuous and disproportionately deep interspaces defining some of the irregularly strong costellae.

Distribution.—GSC locality 60941 (two specimens).

Order Strophomenida Öpik, 1934
Suborder Orthotetidina Waagen, 1884
Unidentifiable orthotetoid

Comments.—There are seven fragmentary specimens of orthotetids in the Hare Fiord collections. They seem to belong to an unusually thin, flattened form of unknown generic affinities. The largest fragment, which is approximately 53 mm wide by 36 mm long, is apparently a flattened dorsal valve. There is no indication of plates in either valve of these fragments and preservation is imperfect.

Distribution.—All seven specimens are from GSC locality 56430.

Suborder Chonetidina Muir-Wood, 1955
Superfamily Chonetoidea Bronn, 1862
Family Rugosochonetidae Muir-Wood, 1962
Subfamily Rugosochonetinae Muir-Wood, 1962
Genus *Chonetinella* Ramsbottom, 1952
Chonetinella cf. *C. jeffordsi* Stevens, 1962
(Fig. 3.6)

*1962 *Chonetinella jeffordsi* Stevens, p. 627, pl. 93, fig. 18, 19.

Description.—Medium size; moderately thick; ventral umbo moderately inflated and extending well posterior to hingeline; cardinal extremities defined by concave flexures; venter moderately broad with narrow, shallow, rounded sulcus that originates near beak; ornament of about 20 to 21 capillae per five mm near anterior margin; dorsal valve and interiors unknown.

Comments.—This single specimen is similar to specimens of *Chonetinella jeffordsi* Stevens, 1962, described and illustrated by both Stevens and Sutherland and Harlow (1973:34).

Distribution.—GSC locality 56430 (one specimen).

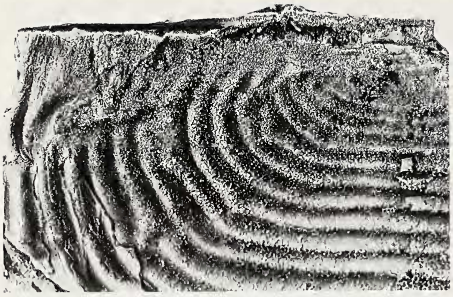
Subfamily Chalimochonetinae Afanas'eva, 1988
Genus *Sokolskya* Aizenverg, 1980
?*Sokolskya* sp.
(Fig. 3.5)

Description.—A single large chonetid ventral valve is tentatively assigned here to the genus *Sokolskya* Aizenverg on the basis of its large size, weakly convex profile with flattened umbonal region, fine ribbing, and short thin ventral septum.

Distribution.—GSC locality 56430 (one specimen).

Suborder Strophalosiidina Waagen, 1883
Superfamily Strophalosioidea Schuchert, 1913
Family Araksalosiidae Lazarev, 1989
Subfamily Quadratiinae Lazarev, 1989
Genus *Plicatiferina* Kalashnikov, 1980
Plicatiferina kalashnikovi, **new species**
(Fig. 3.1–3.4)

Holotype.—An incomplete ventral valve showing the hingeline spines, GSC 115544, from GSC locality C-5202, Figure 3.2.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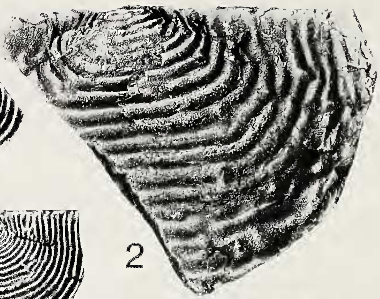
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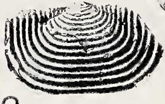
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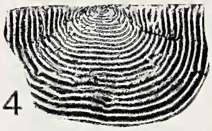
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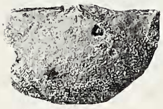
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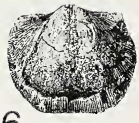
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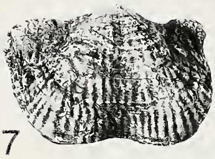
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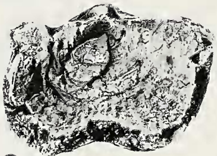
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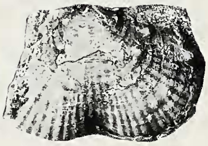
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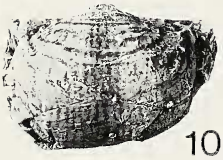
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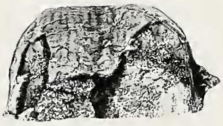
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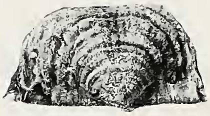
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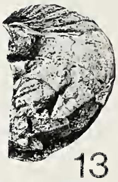
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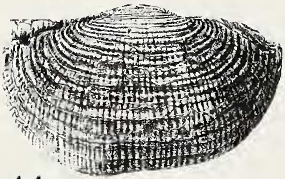
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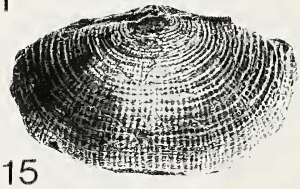
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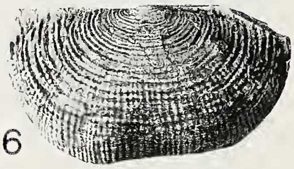
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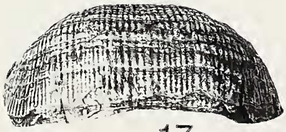
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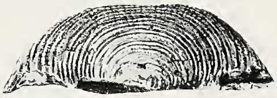
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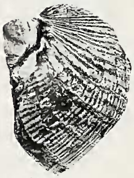
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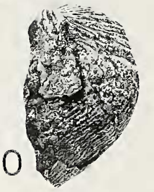
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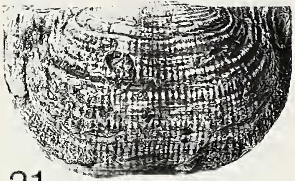
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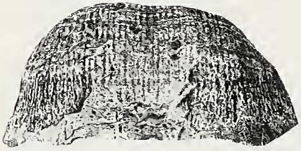
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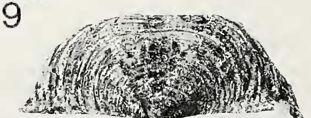
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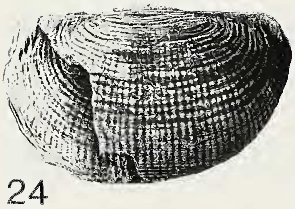
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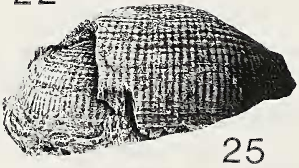
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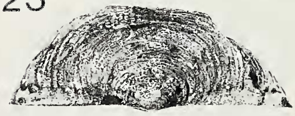
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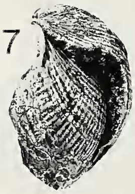
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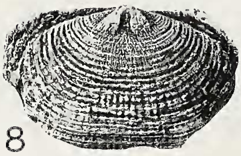
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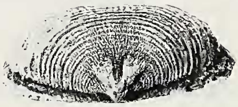
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Table 4.—*Measurements (in millimeters) of the types of* Plicatiferina kalshnikovi *n. sp.*

GSC number	Locality	Length	Width
115543	56430A	15.0+	18.6+
115544	C-5202	19.1+	24.3+
115545	56430A	14.1	21.3+
115546	C-5202	16.6	25.7

Paratypes.—A ventral valve with a disarticulated dorsal valve impressed against it, GSC 115543, from GSC locality 56430A, Figure 3.1; a small ventral valve, GSC 115545, from GSC locality 56430A, Figure 3.3; a natural mold of a dorsal valve exterior, GSC 115546, from GSC locality C-5202, Figure 3.4.

Description.—Medium size; outline transversely subquadrate; maximum width at hingeline; very thin profile; both valves flattened, nearly planoconvex with very thin body cavity; both valves entirely covered with slightly irregular concentric rugae, numbering about nine to 12 per cm in largest specimens.

Ventral valve weakly convex with weakly concave lateral extremities; beak very small, projecting slightly posterior to hingeline; umbonal region very slightly inflated, remainder of valve flattened; interarea flattened or slightly concave, low, apsacline; delthyrium apparently open; five or more pairs of regularly spaced spines at hingeline directed posterolaterally at angle of 30 to 45 degrees to hingeline; fine low spines on body of shell rare, scattered, on small nodes or occasionally short, elongate ridges; teeth small; other interior details unknown.

Dorsal valve nearly flat; dorsal interarea absent or not observed; spines absent; rugae as in opposite valve; interior with low bilobed cardinal process; other internal details not observed. (Note: a dorsal interior from the Ladrones Limestone of southeastern Alaska has an alveolus in front of a small bilobed cardinal process which is flanked by small transverse tooth sockets. The specimen is spalled anteriorly and no muscle scars or other internal details are indicated.)

Diagnosis.—Medium size *Plicatiferina* with nearly regular concentric rugae and a row of hingeline spines directed posterolaterally at a moderately low angle to the hingeline.

Measurements.—See Table 4.

Comparisons.—This species externally resembles the holotype of *Plicatiferina pseudoplicatilis* (Stepanov, 1948), from the Carboniferous (Moscovian or Kasimovian?) of Bashkiria, differing mainly in its more regular rugae. A row of hingeline spines has never been reported in this species. Stepanov's paratypes have a more rounded outline with irregular bifurcating rugae than this Hare Fiord species. Kalashnikov (1980) and Lazarev (1990:pl. 40, fig. 8–11) illustrated specimens of *P. neoplicatilis* (Stepanov, 1939) from Cape Chaika showing this irregular rugation, as does *P. borealica* Kalshnikov, 1980. All of these Russian species

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Fig. 3.—Chonetoids, strophalosioids, and productoids. 3.1–3.4, *Plicatiferina kalashnikovi* n. sp.; 3.1, dorsal view showing ventral interarea and teeth, GSC 115543, × 4; 3.2, the holotype, a ventral valve showing spine bases at hingeline, GSC 115544, × 2; 3.3, 3.4, two ventral valves, GSC 115545, 115546, × 1. 3.5, ventral valve of ?*Sokolskya* sp., GSC 115547, × 1. 3.6, ventral valve of *Chonetinella* cf. *C. jeffordsi* Stevens, 1962, GSC 115548, × 1. 3.7–3.13, *Hystriculina* cf. *H. wabashensis* (Norwood and Pratten, 1855); 3.7, 3.8, ventral and dorsal views of an articulated specimen, GSC 115549; 3.9, natural mold of dorsal exterior, GSC 115550; 3.10–3.13, ventral, anterior, posterior, and lateral views of ventral valve, GSC 115551, all × 1.5. 3.14–3.29, *Lazarevia stepanowensis* n. sp.; 3.14–3.19, ventral, dorsal, dorsal mold, anterior, posterior, and lateral views of the holotype, GSC 115552; 3.20–3.23, lateral, ventral, anterior, and posterior views of a large ventral valve paratype, GSC 115553; 3.24–3.27, ventral, anterior, posterior, and lateral views of a nearly complete paratype with a portion of the dorsal mold exposed, GSC 115554; 3.28, 3.29, ventral and posterior views of a natural mold paratype of the ventral interior showing muscle field, GSC 115555; all × 1.

are significantly younger than *P. kalashnikovi*, ranging from Late Moscovian to Kasimovian in age.

Brunton et al. (1994) recently redescribed the type species of the chonopectinid genus *Semenewia* Paeckelmann, 1931. This genus is similar to *Plicatiferina* in having a flattened, regularly rugose "bauplan" with well-developed interareas in both valves and a row of spines at the hingeline. The surface is finely striate or capillate. Internally, the bilobed cardinal process is supported by a median septum. No radial micro-ornament has been observed in either the Hare Fiord Formation or Ladrones Limestone specimens which are of similar age. If the dorsal interior of the Ladrones specimen described above can be assumed to also typify the Hare Fiord Formation, it is safe to say that these late Bashkirian or early Moscovian specimens do not belong in *Semenewia*.

Distribution.—GSC locality C-5202 (34 specimens); GSC locality 56430A (two specimens). This species, or one very similar to it, occurs in collections of the Ladrones Limestone of southeastern Alaska. This material was collected in 1918 by G. H. Girty of the U. S. Geological Survey.

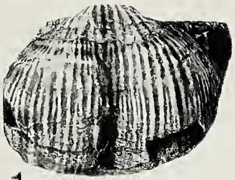
Suborder Productidina Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Productellidae Schuchert, 1929
Subfamily Productininae Muir-Wood and Cooper, 1960
Tribe Paramarginiferini Lazarev, 1986
Genus *Eomarginiferina* Brunton, 1966
?*Eomarginiferina* sp.
(Fig. 6.11–6.15)

Comments.—These two specimens differ from the species described below as *Eomarginifera* in their narrower subtrigonal outline, similar to that seen in the genus *Eomarginiferina* Brunton. The mold of the dorsal exterior has the characteristic concave grooves delineating the ears that indicate the presence of a strong ridge wrapping around the ears of the dorsal valve interior. Unfortunately, one ear of the ventral valve is missing and the other is spalled making it impossible to determine whether or not there were halteroid spines on the ears. For this reason the assignment to *Eomarginiferina* is queried. Furthermore, this genus is not known above the Viséan.

Distribution.—GSC locality C-5202 (one ventral valve, one dorsal valve mold).

→

Fig. 4.—Productoids. 4.1–4.6, ?*Retimarginifera* sp., ventral, dorsal, mold of dorsal exterior, lateral, anterior, and posterior views, GSC 115556, × 1.5. 4.7–4.23, *Rugivestis pristina* n. sp.; 4.7, mold of dorsal exterior paratype, GSC 115557; 4.8–4.19, lateral, ventral, anterior, and posterior views of three ventral valves, GSC 115558–115560, respectively, including the holotype (GSC 115558) and two paratypes; 4.20–4.23, ventral, dorsal, partial dorsal exterior mold, and lateral views of a nearly complete specimen, GSC 115561; all × 1.5. 4.24–4.43, *Maemia gelida* n. sp.; 4.24–4.28, ventral, dorsal, mold of dorsal exterior, posterior, and lateral views of the large holotype, GSC 115562; 4.29–4.31, ventral, dorsal, and mold of dorsal exterior of a small paratype, GSC 115563; 4.32–4.43, ventral, anterior, posterior, and lateral views of three ventral valve paratypes, GSC 115564–115566, respectively; all × 2.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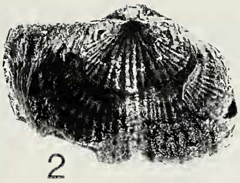
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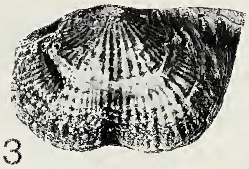
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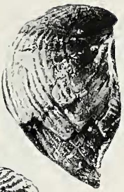
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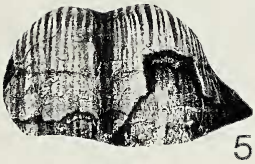
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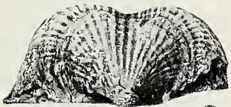
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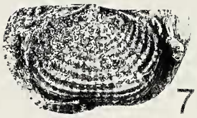
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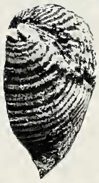
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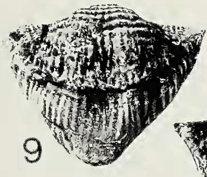
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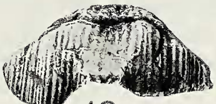
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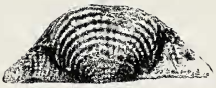
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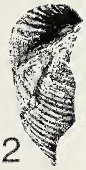
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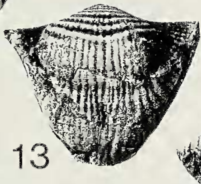
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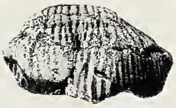
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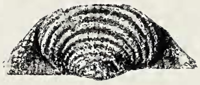
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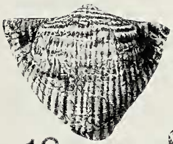
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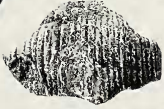
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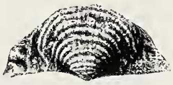
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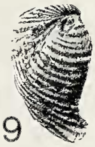
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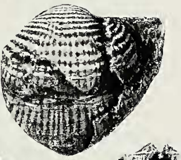
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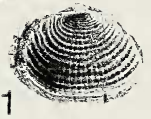
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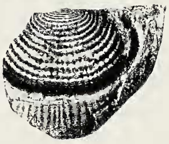
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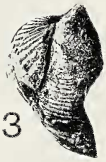
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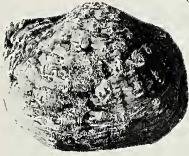
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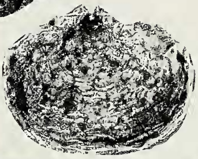
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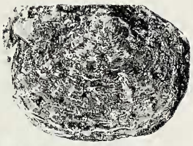
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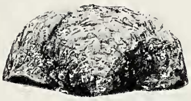
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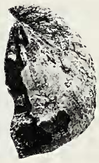
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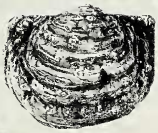
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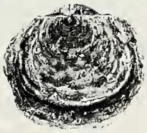
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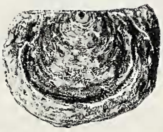
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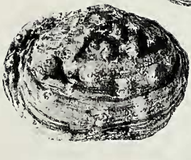
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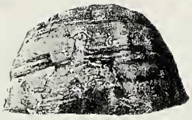
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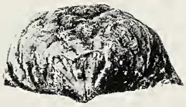
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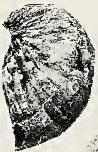
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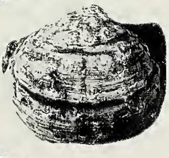
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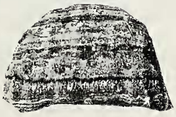
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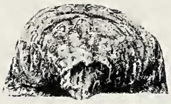
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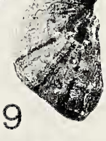
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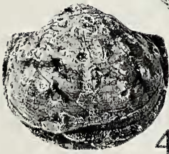
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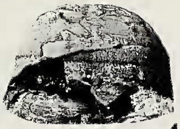
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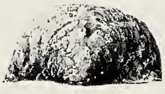
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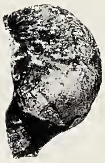
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Table 5.—*Measurements (in millimeters) of the types of* Rugivestis pristina *n. sp. from GSC localities 56430 and 56430A.*

GSC number	Length	Width	Height	Surface length
115558	14.9	18.8	8.5	21.8
115559	14.8	18.4	6.7	21.3
115560	12.6	15.0	7.1	19.9
115561	14.0	—	6.9	20.2

Genus *Rugivestis* Muir-Wood and Cooper, 1960

Rugivestis pristina, **new species**

(Fig. 4.7–4.23)

Holotype.—GSC 115558, Figures 4.8–4.11, from GSC locality 56430.

Paratypes.—GSC 115557, Figure 4.7, GSC locality 56430A; 115559, Figures 4.12–4.15, GSC locality 56430A; 115560, Figures 4.16–4.19, from GSC locality 56430; 115561, Figures 4.20–4.23, from GSC locality 56430A.

Description.—Medium size for genus, transversely trigonal in outline; maximum width at hingeline; both valves strongly geniculate; body cavity thin; lateral profile moderately inflated, subangular.

Ventral valve with visceral disc wider than long, evenly and moderately convex, abruptly delimited from trail by strong cincture; ears large, flattened, weakly costellate, lacking rugae, defined by abrupt straight posterolateral vertical cincture of visceral disc; cardinal extremities formed as vertical flanges at 90-degree angle to ventral surface of ears; trail long and commonly anteriorly nasute; trail may be rounded, flattened, or have shallow sulcus posteriorly; visceral disc, excluding ears, reticulate, ornamented by moderately coarse rugae and moderately strong costellae, about seven to ten in five mm, commonly seven or eight; rugae abruptly terminate at ear ridges; trail with costellae only; spines rare, commonly with one or two pairs symmetrically arranged on visceral disc and one or more others scattered on visceral disc; spines on trail not observed; interior unknown.

Dorsal valve moderately concave; ears defined by straight posterolateral ridge as in opposite valve; trail short; anterior portion of visceral disc and trail with low fold; small protegulal node at hingeline; ornament of visceral disc similar to opposite valve; cincture absent on exterior molds; spines on dorsal visceral disc not observed; interior poorly known, with lateral ridges diverging from hingeline and presumably following cincture; other details not observed.

Measurements.–See Table 5.

Diagnosis.—This species is characterized by moderate size, coarse ribbing, nonrugose ears, and moderately nasute trail.

Comments.—*Rugivestis pristina*, n. sp., is similar in most respects to both *Rugivestis carinata* (Muir-Wood and Cooper, 1957), the type species, and *R. kutorgae* (Chernyshev, 1902). The former, of Middle Permian age, is smaller and has a ventral sulcus on the ventral visceral disc, a narrowly nasute trail, and weakly rugose ears. The latter, of Asselian or Early Permian age, is considerably larger and most specimens are not nasute. In addition the ears are proportionately smaller and bear good rugae. The genus is quite rare and the dorsal interior is still unknown so far as we know.

Distribution.—GSC locality 56430 (four ventral valves); GSC locality 56430A (four ventral valves, one mold of dorsal exterior, two partially bivalved specimens); GSC locality C-4087 (one ventral valve). This species, or one very similar to it, also occurs in the Ladrones Limestone of southeastern Alaska.

Table 6.—*Measurements (in millimeters) of* ?Fimbrinia borealis *n. sp. from GSC locality 56430.*

GSC number	Valve	Length	Width	Height	Surface length
115582	ventral	11.1	10.6	5.4	17.0
115583	ventral	10.0	10.9	4.8	14.3
115584	dorsal	8.5	11.2	4.6	—

Subfamily Overtoniinae Muir-Wood and Cooper, 1960
Tribe Overtoniini Muir-Wood and Cooper, 1960
Genus *Fimbrinia* Cooper, 1972
?*Fimbrinia borealis*, **new species**
(Fig. 6.33–6.43)

Holotype.—GSC 115582, Figures 6.33–6.36, a ventral valve, from GSC locality 56430.

Paratypes.—GSC 115583 and 115584, Figures 6.39–6.43, a ventral valve and a natural mold of the dorsal exterior, from same locality as holotype.

Description.—Small; strongly concavoconvex, body cavity thin; outline subovate; greatest width usually at hingeline, rarely at midlength; lateral profile subguttate to subovate; anterior profile bell-shaped.

Ventral valve strongly inflated posteriorly, most convex in umbonal region; beak small, scarcely overhanging hingeline; venter well rounded in both views, flanks sloping steeply to lateral margins; ears of moderate size, subangular, well defined by concave flexures; trail moderately convex; entire surface strongly rugose and thickly lamellose with strong, moderately broad, irregular rugae; spine bases nearly regularly spaced, arranged in concentric rows along crests of rugae; interior unknown.

Dorsal valve strongly concave; most concave posteriorly; ears delimited by convex flexures; very small protegulal node present at midhingeline; trail absent; ornament consisting of strong lamellose rugae only; spines and dimples apparently absent; interior unknown.

Measurements.—See Table 6.

Diagnosis.—This species is characterized by its small size, rounded outline, strongly convex venter, tumid profile, and coarse rugose ornament on both valves.

Comments.—The dorsal valve of this species is poorly known. The two specimens at hand are spalled dorsal interiors and do not give any indication of the presence of spines or dimples on the exterior surface as one would expect in the genus *Fimbrinia*. However, the state of preservation of these specimens is far from perfect and we cannot discount the possibility that the true ornament is not fully expressed in these specimens.

This species cannot be assigned to a genus or even family with confidence. The strong rugae on both valves, especially the dorsal valve, are unusual for the genus *Fimbrinia* or, for that matter, *Overtonia*. The apparent absence of dorsal spines is even more troubling. Assignment to the genus *Fimbrinia* is a name choice of convenience, for this species must have a genus name. Its distinctive shape, profile, and ornament are reason enough to propose a new species but we have little idea as to its true congeners.

Distribution.—GSC locality 56430 (five ventral valves, two dorsal valves).

Tribe Krotoviini Brunton, Lazarev and Grant, 1995
Genus *Krotovia* Frederiks, 1928
Krotovia cf. *K. spinulosa* (J. Sowerby, 1814)
(Fig. 6.31, 6.32)

1814 *Productus spinulosus* J. Sowerby, p. 155, pl. 68, fig. 3.

Description.—Medium size; outline subcircular to slightly transversely subovate; ventral valve moderately and almost evenly convex, most convex in umbonal region; umbonal region moderately inflated, narrow, moderately incurved; beak small, slightly overhanging hingeline; ornament of weak, closely spaced rugae, strongest near sides of umbo, and concentric rows of round, small, tubercular spine bases crudely arranged in quincunx; widely spaced growth lamellae rarely preserved; spines apparently erect; other details unknown.

Comments.—This Arctic species conforms fairly closely to Brunton's (1966) redescription of *Krotovia spinulosa* (J. Sowerby) from the Upper Viséan of Ireland. It differs mainly in having stronger rugation and a slightly narrower umbonal region.

Distribution.—GSC locality 56430 (three ventral valves).

Krotovia cf. *K. lamellosa* Brunton, 1966
(Fig. 6.28–6.30)

1966 *Krotovia lamellosa* Brunton, p. 225, pl. 13, fig. 8–16; pl. 14, fig. 1–19.

Description.—Small, outline subcircular; ventral umbonal region strongly inflated, narrow, strongly incurved; beak small, overhanging hingeline; ornament consisting only of lamellose growth lamellae; fine spines of variable size arranged in concentric rows on growth lamellae; other details not observed.

Comments.—This solitary specimen agrees in most respects with Brunton's (1966) description and illustrations of *Krotovia lamellosa* from the Upper Viséan of Ireland. It differs only in having fewer spines on the growth lamellae.

Distribution.—GSC locality 56430 (one ventral valve).

Subfamily Marginiferinae Shehli, 1954
Tribe Paucispiniferini Muir-Wood and Cooper, 1960
Genus *Hystriculina* Muir-Wood and Cooper, 1960
?*Hystriculina* cf. *H. wabashensis* (Norwood and Pratten, 1855)
(Fig. 3.7–3.13)

1855 *Productus wabashensis* Norwood and Pratten, p. 13, pl. 1, fig. 6a–d.

Description of Hare Fiord Specimens.—Small, strongly concavoconvex; outline of visceral disc subquadrate; greatest width at hingeline; both valves moderately geniculate; cardinal extremities subangular; lateral profile nearly semicircular; anterior profile subquadrate to subtrapezoidal; shell substance thin.

Ventral valve strongly inflated, most convex at point of geniculation; visceral disc only moderately convex; flanks dropping steeply to lateral margins; cardinal extremities well defined by concave flexures; beak small, projecting posteriorly slightly beyond hingeline; umbonal region not much inflated, subtending an angle of about 90 to 100 degrees; sulcus well developed, originating on anterior half of visceral disc, becoming deeper and extending to anterior margin; ornament on visceral disc consisting of moderately strong, nearly regular, low rugae on whole visceral disc and weak costae anteriorly; flanks and venter with numerous low, rounded, variably strong costellae, about seven to eight per five mm near point of geniculation; erect spine bases sparsely scattered on visceral disc and trail, several finer spines in row along hingeline; interior not observed.

Dorsal valve weakly concave in visceral disc; cardinal extremities well set off by convex flexures; sulcus originating in anterior third of visceral disc; ornament consisting of weak rugae and scattered, rounded pits on visceral disc; ribbing on trail complementary to opposite valve; spines apparently absent; interior not observed.

Comments.—This genus has heretofore been restricted to much younger horizons and the generic identification should be viewed with caution. These Hare Fiord specimens differ little externally from the specimens of *H. wabashensis* illustrated by Sturgeon and Hoare (1968) from the Ames Limestone (Upper Missourian) of Ohio. The ears of this Arctic species are considerably smaller than on those illustrated by Dunbar and Condra (1932) from the Missourian and Virgilian of Nebraska.

Distribution.—GSC locality 56430 (16 specimens); GSC locality 56430A (one ventral valve).

Genus *Retimarginifera* Waterhouse, 1970
?*Retimarginifera* sp.
(Fig. 4.1–4.6)

Description.—Small to medium size; strongly concavoconvex; body cavity thin; outline subquadrate; maximum width at hingeline; ears medium size, not large; visceral disc strongly geniculated; trail moderately long.

Ventral valve strongly inflated; sulcus well developed, originating in umbonal region, becoming uniformly deeper and wider over much of valve; angular ears defined by concave flexures; visceral disc weakly convex, most convex near beak, weakly reticulate with few irregularly spaced rugae intersected by numerous simple or bifurcating fine costae on anterior portion; trail with moderately strong costae, about eight to ten per five mm; spines sparsely distributed, with single strong spine on ears, pair of strong spines on sides of umbo, and few fine spines on umbo and near hingeline; interior unknown.

Dorsal valve strongly concave; fold originating in umbonal region; ears well delimited by abrupt convex flexures; ornament complementary to opposite valve but with few rounded pits on visceral disc; spines absent; interior unknown.

Comments.—This species is represented in the Hare Fiord by only one nearly complete specimen. Another poorly preserved ventral valve may belong here as well. The lack of a dorsal marginal ridge or multiple trails eliminates it from the Marginiferinae. There is superficial similarity to the Late Carboniferous genus *Jiguliconcha* Lazarev, 1990, but that genus has weak, fine ribbing, and no halteroid spines on the ears or umbo, but it does have a row of spines on the lateral slopes unlike the Hare Fiord specimen. The modest size, thin body cavity, weakly reticulate visceral disc, paired halteroid spines at the ears and umbo suggest placement in the subfamily Hystriculininae. Assignment within this subfamily is difficult. The Permian genus *Retimarginifera* Waterhouse is similar in most respects but has a much more strongly reticulate visceral disc. Therefore we assign it here with considerable uncertainty.

Distribution.—GSC locality C-5202 (one ventral valve); GSC locality 56430 (one ventral valve).

Subfamily Plicatiferinae Muir-Wood and Cooper, 1960
Tribe Plicatiferini Muir-Wood and Cooper, 1960
Genus *Lazarevia*, **new genus**

Type Species.—*Lazarevia stepanowensis*, n. sp.

Derivation of Name.—Named in honor of the productid brachiopod specialist S. S. Lazarev.

Diagnosis.—Large for tribe, outline transverse; both valves with vertical flanges at cardinal extremities; ornament consisting of weak, irregularly spaced rugae on visceral disc, and numerous uniform costae on trail and anterior portion of visceral disc, forming weak reticulation on anterior portion of disc; fine spine bases scattered sparsely over surface of ventral valve; row of several fine spines close to hingeline on each side of umbo; row of erect spine bases wrapping around ears to posterolateral margins; dorsal spines absent; ventral interior with low rim of thickened shell matter extending around auriculations and near anterior and lateral margins of valve.

Comments.—This new genus is most similar to, and possibly derived from, the Viséan genus *Plicatifera* Chao, 1927. It differs in having much weaker, more irregular rugae, a shorter trail, more numerous spines on the ventral valve with a row along the hingeline and another row wrapping around the ears to the posterolateral margins. Internally, there is a low rim extending around the whole ventral valve. *Plicatifera* has strong, regular rugae on the visceral disc and a moderately long, well-developed trail. The ventral interior seems to lack the thickened rim seen in *Lazarevia* and the spine distribution is much different. Other members of this tribe, such as *Ferganoproductus* Galitzkaya, 1977 and *Rugoconcha* Jin and Sun, 1981, can be differentiated by the following characters. *Ferganoproductus* has irregular wavy rugae on the visceral disc, lacks costae, and has numerous elongated spine tubercles crudely arranged in quincunx on the ventral valve. It also may have strong, erect spines on the dorsal valve. *Rugoconcha* is based on *Plicatifera chaoi* Grabau, 1936, but the few poor photographs available show specimens that seem more similar to *Plicatiferina* Kalashnikov than *Plicatifera* Chao. It has strong, regular, numerous rugae over the entire surface, lacks ribs, seems to lack a trail, and has scattered spine bases. The dorsal valve appears to be unknown as does ventral valve morphology as seen from a dorsal view.

Distribution.—Late Bashkirian to early Moscovian of Ellesmere Island, Canadian Arctic Archipelago.

Species Assigned.—Monotypic.

Lazarevia stepanowensis, **new species**
(Fig. 3.14–3.29)

Holotype.—GSC 115552, Figures 3.14–3.19, a nearly complete specimen from GSC locality 56430.

Paratypes.—GSC 115553, Figures 3.20–3.23, a ventral valve; GSC 115554, Figures 3.24–3.27, both valves partially preserved; GSC 115555, Figures 3.28 and 3.29, natural mold of ventral interior; all from GSC locality 56430.

Description.—Outline transversely semicircular to subovate; maximum width at or slightly anterior to hingeline; strongly concavoconvex with thin body cavity; lateral profile subsemicircular, evenly convex.

Ventral valve strongly and almost evenly convex in lateral profile; venter flattened or with weak sulcus; ears of moderate size, subangular, defined by concave flexures ventrally and nearly vertical gutterlike flanges laterally; lateral slopes moderately convex; umbonal region broad, weakly inflated; beak small; ornament consisting of numerous low, fine, irregularly spaced rugae on visceral disc and numerous fine, mostly regular costae or coarse costellae that originate on anterior portion of visceral disc and extend to anterior margin, about six or seven in five mm at 20-mm surface measure from beak; fine spine bases scattered sparsely over surface; row of several (four or more) fine spines very close to hingeline on each side of umbo; row of seven or eight erect spine bases wrapping around ears to posterolateral margins; interior smooth, lacking shagreen, in umbonal region; with low rim, strongest at auriculations, that extends around entire visceral disc except for umbo, producing weak cincture in spalled specimens; adductor scars chordate, posteriorly placed in umbonal region, moderately impressed; diductors not impressed, poorly delimited, weakly striate.

Dorsal valve slightly less convex than opposite valve; gutterlike flanges at cardinal extremities similar to those of opposite valve; small, prominent protegulal node at posteromedial margin; fold, if present, weak and originating on anterior portion of visceral disc; ornament similar and complementary to ventral valve but weaker; spine bases not present; interior with small, sessile, bilobed cardinal process, short, thin median septum that extends forward from near base of cardinal process to about half length of visceral disc, moderately developed lateral ridges that diverge from hingeline at low angle extending about halfway toward auriculations, and numerous strong endospines anteriorly; other internal details unobserved.

Measurements.—See Table 7.

Comments.—This Arctic species bears some superficial resemblance to species

Table 7.—*Measurements (in millimeters) of* Lazarevia stepanowensis *n. sp. from GSC locality 56430.*

GSC number	Length	Width	Height	Surface length
115552	22.3	32.6	14.2	35.3
155553	25.3	40.0	16.5	39.0
115554	24.3	39.0	15.8	36.2

of the genus *Desmoinesia* Hoare but can readily be differentiated from that genus by its larger size, more transverse outline, lack of dorsal spines, the presence of lateral flanges, and a weak cincture on spalled surfaces of the ventral valve that reflects a low thickening or rim that extends around the interior of the ventral valve.

Plicatifera pseudoplicatilis (Muir-Wood), as illustrated in Brunton et al. (1993), is similar in size, transverse outline, and general ornament but differs in having much stronger and more regular rugae, a longer trail, and an almost completely reticulate visceral disc.

Distribution.—This species is common at GSC locality 56430 (90 specimens).

Tribe Semicostellini Nalivkin, 1979
Genus *Maemia* Lazarev, 1997
Maemia gelida, **new species**
(Fig. 4.24–4.43)

Holotype.—GSC 115562, Figures 4.24–4.28, from GSC locality C-5202.

Paratypes.—GSC 115563–115566, Figures 4.29–4.43, from GSC locality C-5202.

Description.—Small, nearly planoconvex; outline transversely subovate; greatest width at about midlength, rarely at hingeline; ears small, compressed, subangular; anterior profile subsemicircular to rounded subtrapezoidal; lateral profile subsemicircular.

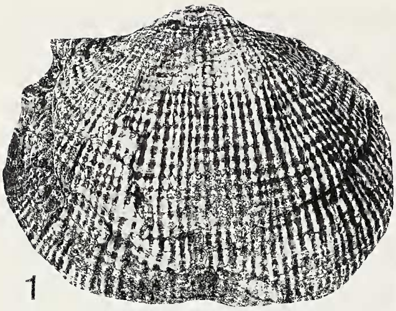
Ventral valve strongly inflated, evenly convex except for more convex umbonal region; visceral disc not delineated; venter weakly convex, flanks dropping steeply to lateral margins; trail very short, not well defined; ears set off by deeply concave flexures; umbonal region weakly inflated and of moderate width; beak small, slightly overhanging hingeline; entire valve weakly and irregularly rugose and slightly lamellose, each strong concentric stricture anterior to strong rugae indicating former position of dorsal visceral disc; coarse, slightly elongate nodular spine bases or tubercles arranged crudely in quincunx over most of valve; finer, more numerous spines on ears, on sides of umbo, and near hingeline; interior not observed.

Dorsal valve almost flat or very weakly concave, except for very short, sharply geniculated trail; small medial protegulal node present; ornament consisting of weaker rugae than those of opposite valve and scattered shallow dimples; numerous fine, scattered spine bases present; interior not observed.

Measurements.—See Table 8.

Table 8.—*Measurements (in millimeters) of the types of* Maemia gelida *n. sp. from GSC locality C-5252.*

GSC number	Length	Width	Height	Surface length
115562	10.2	13.0	6.1	16.9
115563	8.5	10.6	5.4	13.4
115564	9.9	12.3	6.6	17.2
155565	9.5	11.5	6.7	16.1
115566	10.1	11.5	6.5	17.5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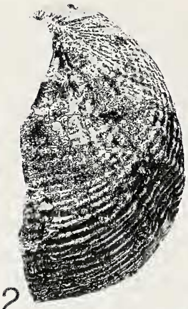
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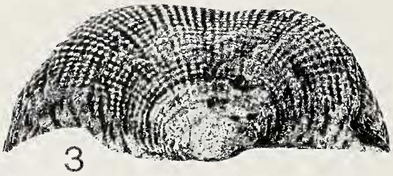
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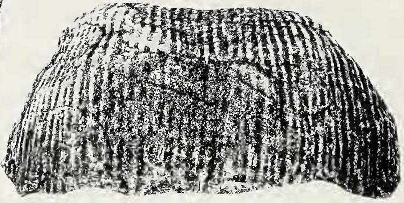
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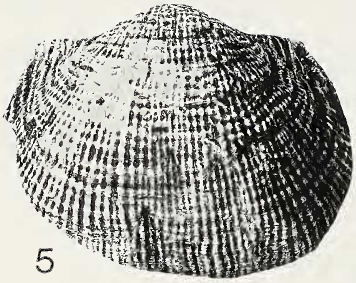
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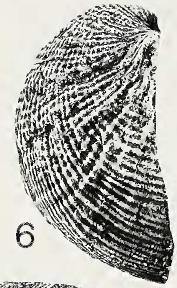
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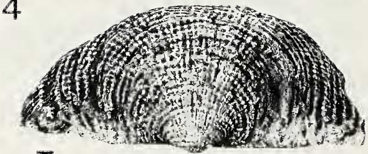
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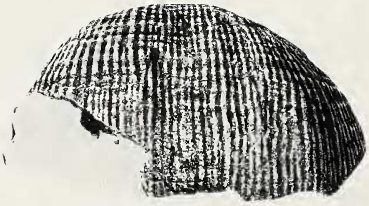
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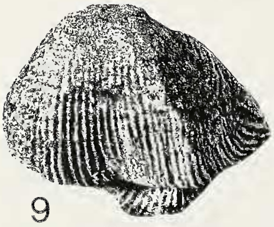
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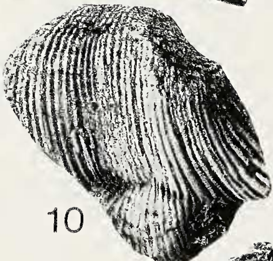
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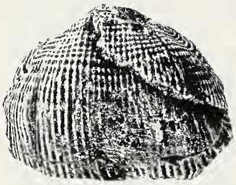
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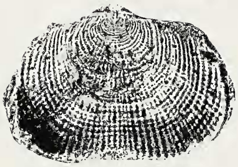
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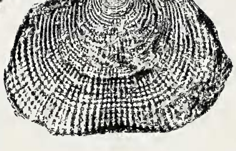
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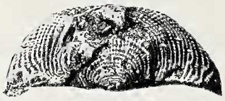
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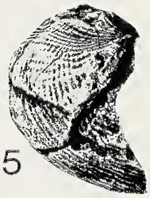
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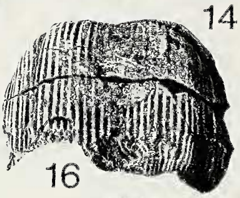
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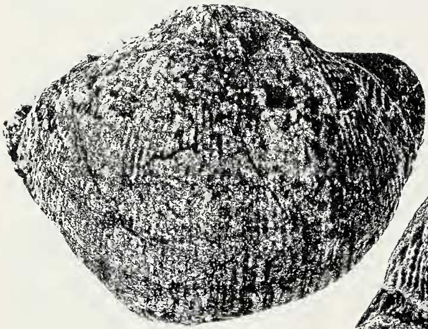
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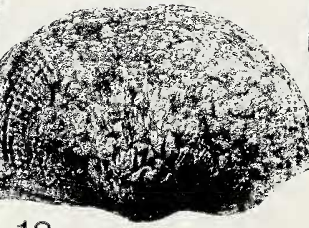
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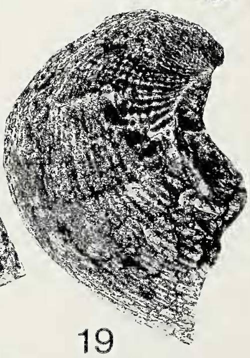
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Diagnosis.—The combined characters of a rugose, spinose, noncostate ornament and flat, spinose dorsal valve with very short trail characterize this species.

Comments.—Despite the small size of this new species its general morphology suggests that it is closely related to the recently described genus *Maemia* Lazarev. The type species of that genus, *Maemia chaykensis* Lazarev, 1997 (in Brunton and Lazarev, 1997), however, is much larger and bears a shallow ventral sulcus and coarse costae on the trail. Another species from the same horizon at Cape Chaika, *Maemia nana* Lazarev, however, is similar to this Canadian species in size and ornament. It differs in having much weaker spine base tubercles and weak, coarse ribbing on the ventral valve.

Distribution.—GSC locality C-5202 (25 specimens); GSC locality 56430 (six specimens).

Family Productidae Gray, 1840
Subfamily Dictyoclostinae Stehli, 1954
Genus *Reticulatia* Muir-Wood and Cooper, 1960
Reticulatia cf. *R. americanus* (Dunbar and Condra, 1932)
(Fig. 5.1–5.8)

1932 *Dictyoclostus americanus* Dunbar and Condra, p. 218, pl. 34, fig. 3–6.

Description.—Large, moderately concavoconvex; outline transversely subovate to subquadrate; maximum width probably near hingeline (ears incomplete in all specimens); lateral profile subsemicircular; anterior profile subtrapezoidal; fold and sulcus moderately developed; body cavity moderately thick.

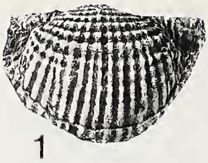
Ventral valve moderately inflated, almost evenly convex, most convex near beak; umbo broad, moderately produced, subtending an angle well in excess of 90 degrees; beak small, slightly overhanging hingeline; flanks moderately convex, sloping steeply to lateral margins; rounded sulcus originating in umbonal region, remaining shallow, sometimes obscure, throughout entire length; ears delimited by concave flexures, not fully preserved; visceral disc delineated by weak geniculation and loss of reticulate ornament; ornament of visceral disc strongly and regularly reticulate with numerous, almost regular rugae intersecting regular coarse costae, about four or five per five mm on anterior portion of visceral disc; spine bases found in row along hingeline, around ears, and scattered elsewhere; interior unknown.

Dorsal valve moderately concave, geniculate; fold low throughout; ears delimited by convex flexures; trail not well preserved; ornament of visceral disc complementary to opposite valve; no spines observed; interior unknown.

Comments.—These incomplete Arctic specimens agree in most observable details with typical *Reticulatia americanus* (Dunbar and Condra), of Missourian or Kazimovian age of Nebraska and surrounding environs. The latter differs little from the Hare Fiord specimens, mainly in having numerous spines scattered on the trail. Muir-Wood and Cooper (1960) emphasized the well-developed ginglymus in this genus, a character not preserved in our specimens. The trail also is broken in all of our specimens. Therefore, identification is tentative.

←

Fig. 5.—Productoids. 5.1–5.8, *Reticulatia* cf. *R. americanus* (Dunbar and Condra, 1932), ventral, lateral, posterior, and anterior views of two ventral valves, GSC 115567 and 115568, × 1. 5.9–5.16, *Kutorginella* cf. *K. mosquensis* Ivanova, 1951; 5.9, 5.10, ventral and oblique views of ventral valve with siphon, GSC 115569; 5.11–5.16, ventral, dorsal, mold of a dorsal exterior, posterior, lateral, and anterior views of a small complete specimen, GSC 115570; both × 1. 5.17–5.19, *Antiquatonia* cf. *A. hermosana* (Girty, 1903), ventral, posterior, and lateral views of a ventral valve showing the spine ridge on the right ear, GSC 115571, × 1.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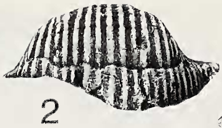
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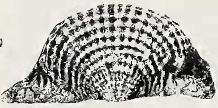
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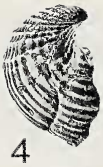
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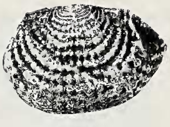
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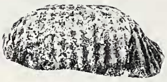
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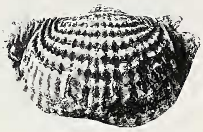
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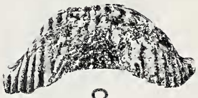
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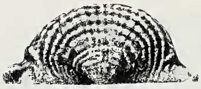
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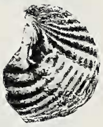
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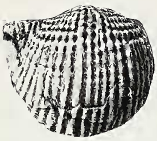
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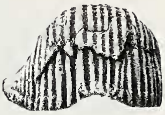
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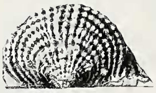
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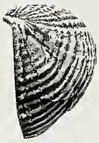
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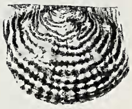
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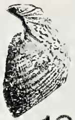
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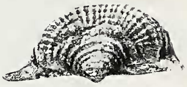
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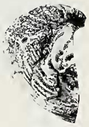
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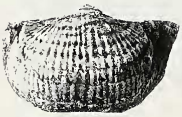
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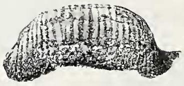
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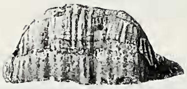
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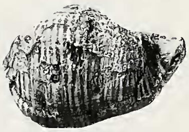
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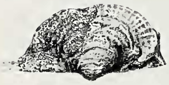
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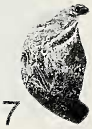
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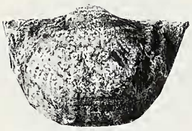
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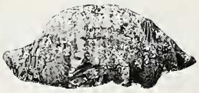
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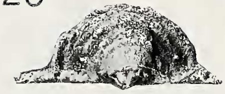
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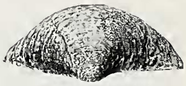
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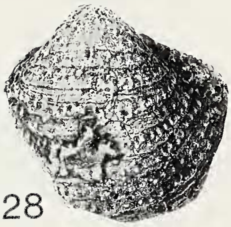
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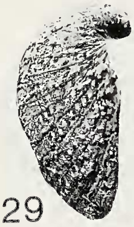
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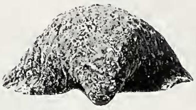
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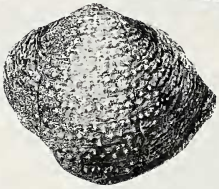
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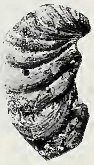
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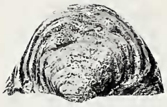
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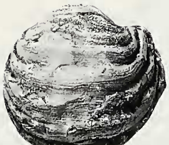
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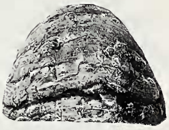
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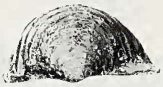
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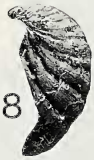
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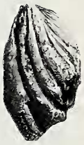
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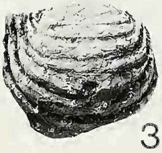
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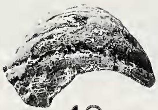
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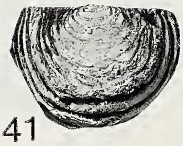
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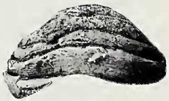
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Distribution.—GSC locality 60194 (two ventral valves and two articulated specimens).

Tribe Kozlowskiini
Genus *Eomarginifera* Muir-Wood, 1930
Eomarginifera sp.
(Fig. 6.1–6.10)

Comments.—This species is assigned to *Eomarginifera* on the basis of having three pairs of halteroid spines on the ears, umbo, and trail of the ventral valve. Deep concave grooves defining the ears indicate that there are strong lateral ridges curving around the ears in the dorsal valve as in *Eomarginifera*. A large fragment of conjoined valves shows the trails of both valves touching each other at the anterior margin, obviating the possibility that this species could be assigned to *Kozlowskia* which has numerous short trails bunched at the anterior margin. The transverse outline and widely spaced pair of halteroid spines on the trail demonstrate that it cannot be assigned to *Eomarginiferina* Brunton, 1966.

Assignment to a species of *Eomarginifera* is more difficult. The coarse ribs and rounded venter of this Arctic species are not usual for the genus *Eomarginifera*. Externally, the ventral valves resemble the species described as *Kozlowskia* sp. by Lazarev (1990:pl. 21, fig. 24b, v), of Moscovian age from the Moscow Basin.

Distribution.—GSC locality 56430 (five ventral valves, two dorsal valve molds, one fragment of conjoined valves); GSC locality C-5202 (one ventral valve).

Genus *Kozlowskia* Frederiks, 1933
?*Kozlowskia splendens* (Norwood and Pratten, 1855)
(Fig. 6.16–6.27)

1855 *Productus splendens* Norwood and Pratten, p. 11, pl. 1, fig. 5a–d.

Description.—Small; outline transversely subsemicircular to subtrapezoidal; greatest width at hingeline; lateral profile subtrigonal to subsemicircular; anterior profile subtrapezoidal to subsemicircular.

Ventral valve strongly inflated with moderately convex visceral disc and less convex geniculated trail; ears large, slightly mucronate or compressed, well delineated by concave flexures; venter rounded to flattened or weakly sulcate; flanks steeply sloping to lateral margins; radial ornament of low, weak costellae, confined to trail and that portion of visceral disc anterior to umbonal region; visceral disc with weak rugae, forming weakly reticulate pattern near point of geniculation; three pairs of halteroid spines at ears, sides of visceral disc, and on trail; few finer spine bases scattered near hingeline and on umbo; interior unknown.

←

Fig. 6.—Productoids. 6.1–6.10, *Eomarginifera* sp.; 6.1–6.4, 6.7–6.10, ventral, anterior, posterior, and lateral views of two ventral valves, GSC 115572 and 115573; 6.5, 6.6, ventral and anterior views of natural mold of dorsal exterior, GSC 115574; all × 1.5. 6.11–6.15, ?*Eomarginiferina* sp.; 6.11–6.14, ventral, anterior, posterior, and lateral views of ventral valve, GSC 115575; 6.15, ventral view of natural mold of dorsal exterior, GSC 115576; all × 1.5. 6.16–6.27, ?*Kozlowskia splendens* (Norwood and Pratten, 1855), ventral, anterior, posterior, and lateral views of three ventral valves, GSC 115577–115579, respectively, × 1.5. 6.28–6.30, ventral, lateral, and posterior views of *Krotovia* cf. *K. lamellosa* Brunton, 1966, GSC 115580, × 3. 6.31, 6.32, ventral and posterior views of *Krotovia* cf. *K. spinulosa* (J. Sowerby, 1814), GSC 115581, × 3. 6.33–6.43, ?*Fimbrinia borealis* n. sp.; 6.33–6.40, ventral, anterior, posterior, and lateral views of two ventral valves, including the holotype (6.33–6.36), GSC 115582 and 115583; 6.41–6.43, ventral, lateral, and anterior views of a mold of the dorsal exterior, GSC 115584; all × 2.

Dorsal valve known only from external molds. Trail sharply geniculated; ears smaller than opposite valve; visceral disc flattened, weakly convex; ornament as in opposite valve but weaker; spines absent; evidence of numerous trails lacking; interior unknown.

Comments.—The large ears, variably developed fold, and obsolescent costellae on the trail characterize these Hare Fiord specimens. In this respect these Arctic specimens are virtually indistinguishable from typical specimens of *Kozlowskia splendens* from Desmoinesian and Missourian beds in the midcontinent, an admittedly highly variable species according to Dunbar and Condra (1932).

The absence of specimens that indicate the presence of a sheaf of closely packed short trails at the dorsal margin is unfortunate. If there is no dorsal rim of numerous trails this species is not a *Kozlowskia* and might be reassigned to another genus such as *Eomarginiferina* Brunton, 1968. However, the weak reticulation and anterior ribbing in this Arctic species are more suggestive of *Kozlowskia* than *Eomarginiferina*.

Distribution.—GSC locality 56430 (six ventral valves); GSC locality 56430A (five ventral valves).

Tribe Retariini Muir-Wood and Cooper, 1960
Genus *Kutorginella* Ivanova, 1951
Kutorginella cf. *K. mosquensis* Ivanova, 1951
(Fig. 5.9–5.16)

1951 *Kutorginella mosquensis* Ivanova, p. 329.

Description.—Medium size; outline subquadrate; lateral profile strongly inflated, subtrapezoidal; anterior profile subquadrate to subtrapezoidal; point of maximum width apparently anterior to hingeline; ears small to medium; fold and sulcus moderately well developed, originating in umbonal region, becoming broader and deeper anteriorly; visceral disc reticulate with numerous rugae intersecting moderately strong costae; costae numbering about five or six in five mm on trail, extending forward over entire trail.

Ventral valve moderately geniculated; ears defined by concave flexures; lateral slopes dropping steeply to lateral margins; trail long with medial tube-like extension formed by distinctive stricture in largest specimen; spine bases scattered over umbonal region and trail with regular row wrapping around each ear; spines along hingeline not observed due to poor preservation; interior not observed.

Dorsal valve with flattened visceral disc and subquadrate outline; ears delimited by low convex flexures; dorsum with low fold; trail at least eight to ten mm long; ornament reticulate; spines absent; irregular rows of rounded pits on ears; interior unknown.

Comments.—The genus *Kutorginella* Ivanova ranges from the uppermost Serpukhovian to the Kungurian and many species have been described. These Hare Fiord specimens resemble *K. mosquensis* Ivanova from the Kazimovian of the Moscow Basin in ornament and development of an incomplete siphonal or tube-like trail extension in large, fully mature specimens. They also fall within the size range of specimens illustrated by Sarycheva (1971:pl. 5, fig. 1a, b) and Sarycheva and Sokolskaya (1952:pl. 37, fig. 230). However, they differ from the specimens illustrated by Sarycheva and Sokolskaya (1952) and Lazarev (1990:pl. 19, fig. 1) in being less transverse and the ears appear to be smaller, although these Hare Fiord specimens are not complete.

Distribution.—GSC locality 56430 (one ventral valve); GSC loc. 4085 (one specimen); GSC locality C-5202 (one ventral valve).

Genus *Antiquatonia* Miloradovich, 1945
Antiquatonia cf. *A. hermosana* (Girty, 1903)
(Fig. 5.17–5.19)

1903 *Productus semireticulatus* var. *hermosanus* Girty, p. 358, pl. 2, fig. 1–4.

Description.—Large, strongly inflated; outline subovate to subquadrate; widest at hingeline; ears large, well defined; ventral sulcus narrow, shallow; visceral disc strongly reticulate, slightly geniculated from long trail; trail costate with about seven to nine costae per cm near anterior margin; ears set off by conspicuous ridge that wraps around ears; coarse spine bases sparsely scattered on trail and visceral disc; spines on ears and umbonal region obscured by poor preservation; other details not observed.

Comments.—The umbonal region of this single ventral valve is slightly crushed. Otherwise this specimen closely resembles the large ventral valve illustrated by Girty (1903:pl. 3, fig. 1–1c). Sutherland and Harlow (1973:pl. 11, fig. 6a–c) illustrated a smaller narrower specimen that otherwise is similar to this Arctic specimen.

Distribution.—GSC locality 56430 (one ventral valve).

Superfamily Echinoconchoidea
Family Echinoconchidae Stehli, 1954
Subfamily Pustulinae Waterhouse, 1981
Genus *Pustula* Thomas, 1914
?*Pustula* sp.
(Fig. 7.2)

Comments.—This single incomplete, slightly distorted ventral valve has mostly slightly elongate spine bases arranged in quincunx, with distinctive scattered, rounded pits between some of the spine bases. There are a few weak, irregular rugae, most noticeable around the ears. The low, rounded profile and vaguely rounded outline combined with this peculiar ornament suggest assignment to the genus *Pustula*, although that genus is more rugose and does not normally have rounded pits between the spine bases of the ventral valve.

Distribution.—GSC locality C-5202 (one ventral valve).

Subfamily Echinoconchinae Stehli, 1954
Tribe Echinoconchini Stehli, 1954
Genus *Echinaria* Muir-Wood and Cooper, 1960
?*Echinaria* sp.
(Fig. 7.1)

Comments.—A single large, partial echinoconchoid ventral valve seems likely to belong in the genus *Echinaria*. Although spine bases cannot be discerned, the shape and size of this specimen suggest assignment here, although a dorsal interior is needed for certain identification.

Distribution.—GSC locality 56430 (one partial ventral valve).

Superfamily Linoproductoidea Stehli, 1954
Family Monticuliferidae Muir-Wood and Cooper, 1960
Subfamily Auriculispinae Waterhouse, 1986
Genus *Liraria* Cooper and Grant, 1975
Liraria paucispina, **new species**
(Fig. 7.3–7.18)

Holotype.—GSC 115587, Figures 7.3, 7.11–7.14, a ventral valve, from GSC locality C-5202.

Paratypes.—GSC 115588, Figures 7.4, 7.15–7.18, a ventral valve; GSC 115589, Figures 7.5 and 7.6, a complete specimen with the visceral disc removed showing the mold of the dorsal exterior; GSC 115590, Figures 7.7–7.10, a large ventral valve; all from GSC locality C-5202.

Description.—Small to medium size; strongly concavoconvex; body cavity thin; outline subovate;

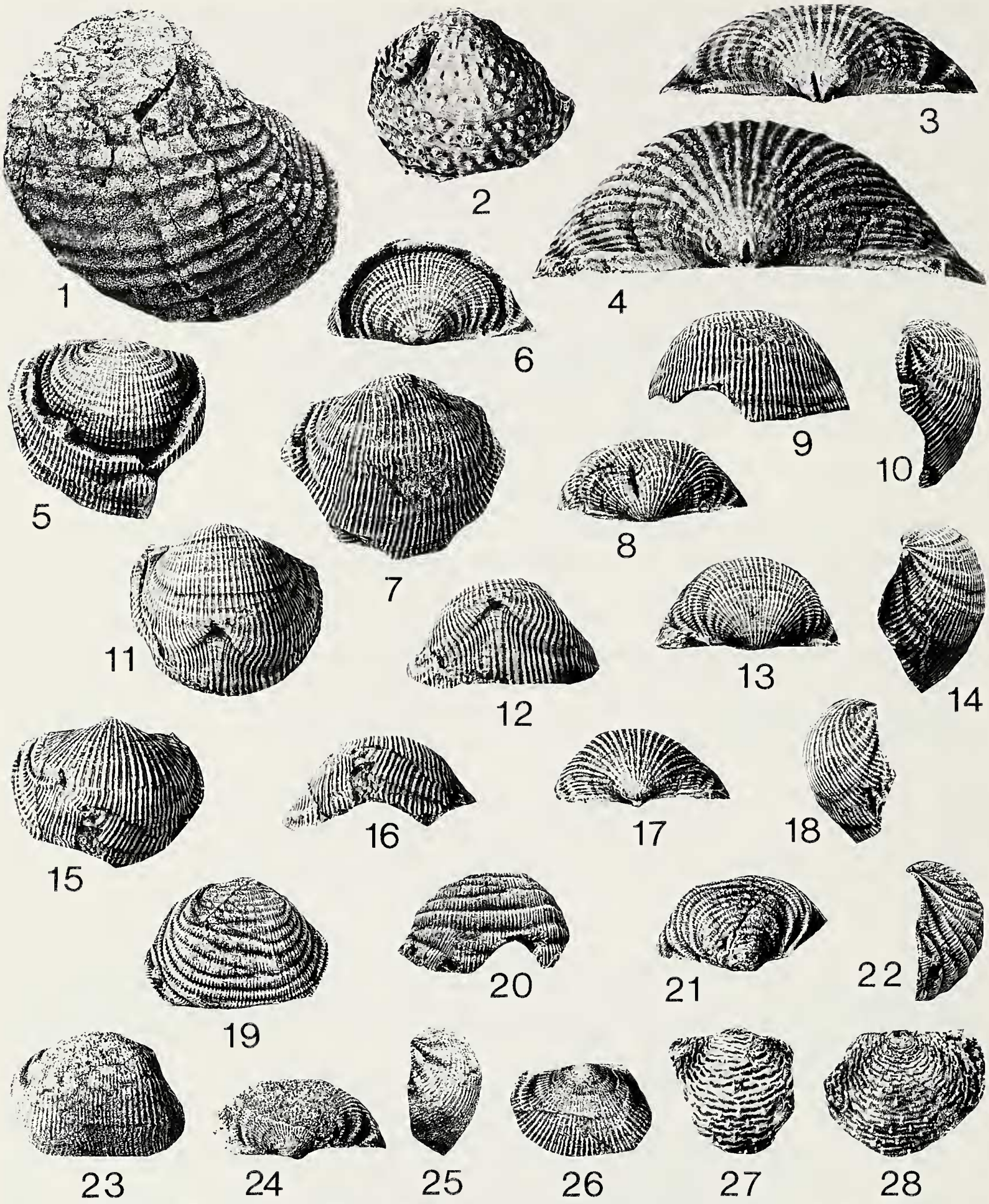

Fig. 7.—Productoids. 7.1, ?*Echinaria*, ventral valve, GSC 115585, × 1. 7.2, ?*Pustula* sp., ventral valve, GSC 115586, × 2. 7.3–7.18, *Liraria paucispina* n. sp.; 7.3, 7.11–7.14, ventral posterior view showing attachment scars and spine bases at hinge, × 4, and ventral, posterior, anterior, and lateral views of the holotype, × 1.5, GSC 115587; 7.4, 7.15–7.18, ventral posterior of a paratype showing attachment scars and spine bases at hinge, × 4, and ventral, posterior, anterior, and lateral views of paratype GSC 115588, × 1.5; 7.5, 7.6, ventral and posterior views of complete paratype with visceral disc removed, GSC 115589, × 1.5; 7.7–7.10, ventral, posterior, anterior, and lateral views of a large ventral valve paratype, GSC 115590, × 1.5. 7.19–7.22, *Fluctuaria* cf. *F. undata* (Defrance, 1826), ventral, anterior, posterior, and lateral views of ventral valve, GSC 115591, × 1. 7.23–7.26, ?*Linoproductus* sp.; 7.23–7.25, ventral, posterior, and lateral views of ventral valve, GSC 115592, × 1; 7.26, ventral view of mold of dorsal exterior, GSC 115593; × 1. 7.27, 7.28, *Cancrinella* sp., ventral exterior and mold of dorsal exterior, GSC 115594 and 115595, × 2.

Table 9.—*Measurements (in millimeters) of* Liraria paucispina *n. sp. from GSC locality C-5202.*

GSC number	Length	Width	Height	Surface length
115589	17.5	17.8+	8.8	27.7
115590	16.9	19.3	7.2	25.6
115587	15.2	17.0	8.7	23.4
115588	12.7	17.7	6.5	20.5

maximum width anterior to hingeline in most specimens; lateral profile strongly convex, most convex in umbonal region; anterior profile and venter almost evenly rounded; trails not produced or differentiated.

Ventral valve strongly inflated posteriorly, most convex in umbonal region; umbo broad; beak small, scarcely overhanging hingeline, with up to three pairs of fine, vertically oriented attachment spines; ears small, flattened, delineated by concave flexures; ornament of fine, rounded costellae, about 11 to 13 per five mm at a surface distance of 15 mm from beak, which increase by intercalation; few rugae limited to sides of umbo and lateral slopes; one or two pairs of prostrate, elongate, laterally or anterolaterally directed spine bases on ears just anterior to hingeline; other spines rare; spines along hingeline usually absent, rarely with one or two pairs of erect spines at hingeline; growth lines very fine, regularly spaced; interior unknown.

Dorsal valve with moderately concave visceral region; prominent rounded protegulal node at hingeline; ears small, defined by convex flexures; fine costellae and rugae as in opposite valve; spines not observed, apparently absent; interior unknown.

Measurements.—See Table 9.

Diagnosis.—This species is characterized by modest size, subovate outline, and one pair (rarely two pairs) of elongated, laterally directed, fine spine bases just anterior to the hingeline.

Comments.—*Liraria paucispina*, n. sp., can be differentiated from the type and only other described species, *Liraria lirata* Cooper and Grant, 1975, from the basal Bone Spring Formation (Leonardian–Artinskian) of west Texas, by its modest size, subovate outline, and pair (rarely two pairs) of elongated, laterally directed, fine spine bases near the hingeline.

This species seems to have been attached throughout life normal to its substrate. All observed attachment areas on the ventral beak bear fine, elongated, vertical impressions such as might be made by productid spines. Nearly all of the specimens from GSC locality C-5202 were recovered from a single small lump of limestone crowded with these shells. It is possible that the spat of this species tended to attach to spines of adults of the same species.

Distribution.—GSC locality C-5202 (100+ specimens, mostly ventral valves); GSC locality 56430 (three ventral valves, one dorsal valve mold); GSC locality 56430A (50 ventral valves).

Family Linoproductidae Stehli, 1954
Subfamily Linoproductinae Stehli, 1954
Genus *Linoproductus* Chao, 1927
?*Linoproductus* sp.
(Fig. 7.23–7.26)

Description.—Medium size; moderately concavoconvex; outline transversely subovate; maximum width near midlength; ears small, slightly compressed; body cavity estimated to be moderately thick; lateral profile rounded, most convex in umbonal region; anterior profile subtrapezoidal.

Ventral valve strongly inflated posteriorly; umbonal region broad; beak small, not appreciably overhanging hingeline; venter flattened or weakly sulcate; flanks weakly convex, sloping moderately steeply to lateral margins; trail, if present, short; entire surface with fine costellae, about nine to 11 per five mm near front margin, which increase by intercalation; three to four rugae on sides of umbo; spine bases not observed, probably because of poor preservation; interior unknown.

Dorsal valve moderately concave; ears delineated by weakly convex flexures; rugae strongest near hingeline, one or two of which may extend around visceral disc; ribbing as in opposite valve; spines absent; interior unknown.

Comments.—Poor preservation of the ventral valve and lack of a dorsal interior makes generic identification difficult. In general aspect this species is most similar to *Linoproductus* Chao but this assignment is far from certain.

Distribution.—GSC locality 56430 (two ventral valves; one mold of dorsal valve exterior).

Genus *Fluctuaria* Muir-Wood and Cooper, 1960
Fluctuaria cf. *F. undata* (Defrance, 1826)
(Fig. 7.19–7.22)

1826 *Productus undatus* Defrance, p. 354.

Description.—This description is based on a single, nearly complete ventral valve.

Medium size; strongly convex; outline transversely subovate; greatest width anterior to midlength; lateral profile almost evenly convex; umbonal region most convex, moderately broad; beak small, slightly overhanging hingeline; venter more weakly convex or slightly flattened; flanks moderately spreading, sloping steeply to lateral margins; ears small, defined by slightly concave flexures; entire surface finely costellate with about 11 to 13 costellae per five mm at surface measure of 20 mm from beak; costellae increase by intercalation; entire valve strongly rugose; rugae irregular, sometimes discontinuous, strongest at sides of umbo; spine bases rare on trail, not observed near hingeline because of poor preservation; ventral interior and dorsal valve unknown.

Comments.—This specimen is similar to the broader specimens of *Fluctuaria undata* figured by Koninck (1843:pl. 12, fig. 2; 1847:pl. 5, fig. 3) from the Viséan of Belgium, and Sarycheva (1937:pl. 7, fig. 2a; Sarycheva et al., 1963:pl. 37, fig. 9) from the Serpukhovian of European Russia and the Kuznets.

Distribution.—GSC locality 56430 (one good ventral valve, five questionable ventral valves). A similar form occurs in the Ladrones Limestone of southeastern Alaska.

Subfamily Grandaurispininae Lazarev, 1986
Genus *Cancrinella* Frederiks, 1928
Cancrinella sp.
(Fig. 7.27, 7.28)

Comments.—There are three imperfectly preserved specimens of this genus in the Hare Fiord collections, all from GSC locality 56430. The distinctive fine radial ornament of this species with elongate quincuntially arranged spine bases on

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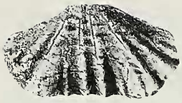
Fig. 8.—Stenoscismatoids and rhynchonelloids. 8.1–8.4, *Stenoscisma* sp., ventral, dorsal, anterior, and lateral views (beak removed by grinding), GSC 115596, × 1. 8.5–8.16, *Careoseptum septentrionalis* n. gen. n. sp., ventral, dorsal, anterior, and lateral views of three specimens, including the holotype (8.9–8.12) and two paratypes, GSC 115597–115599, respectively, × 2. 8.17–8.20, *Cenorhynchia* sp., ventral, dorsal, anterior, and lateral views, GSC 115600, × 2. 8.21–8.28, *Exlaminella insolita* n. gen. n. sp., ventral, dorsal, anterior, and lateral views of two specimens, including the holotype (8.25–8.28, GSC 115601), and the paratype, GSC 115602, × 2. 8.29–8.40, ?*Elassonia sverdrupensis* n. sp., ventral, dorsal, anterior, and lateral views of three specimens, including the holotype (8.29–8.32) and two paratypes, GSC 115603–115605, respectively, × 2. 8.41–8.48, ?*Hemileurus* sp., ventral, dorsal, anterior, and lateral views of two specimens, GSC 115606 and 115607, × 2.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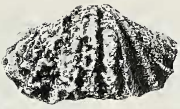
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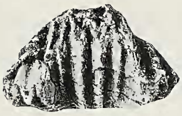
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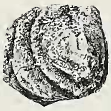
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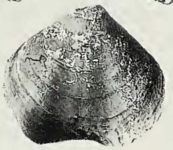
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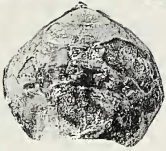
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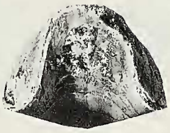
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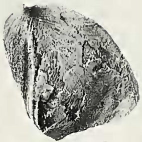
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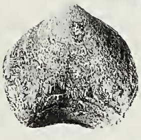
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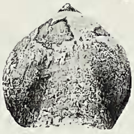
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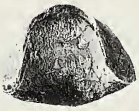
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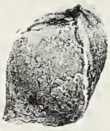
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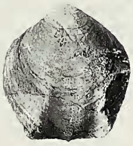
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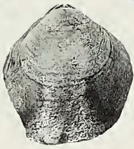
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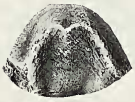
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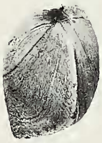
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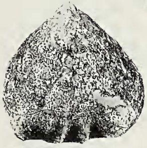
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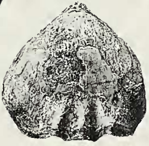
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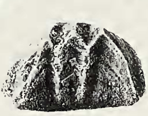
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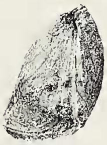
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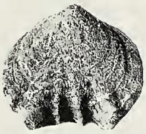
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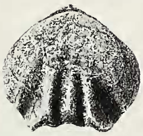
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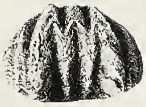
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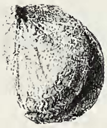
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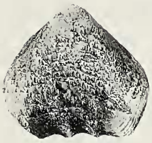
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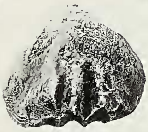
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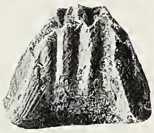
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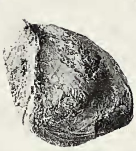
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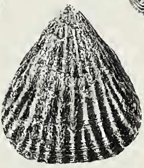
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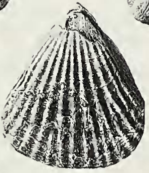
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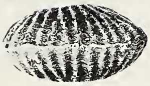
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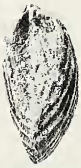
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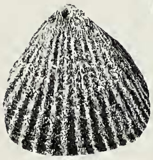
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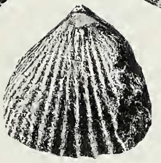
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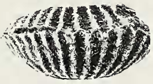
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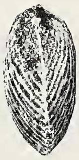
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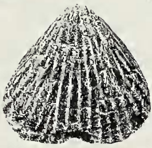
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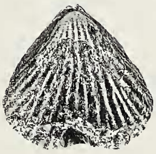
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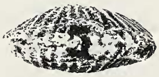
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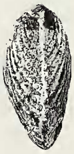
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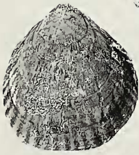
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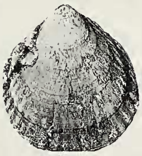
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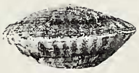
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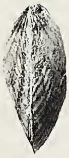
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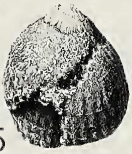
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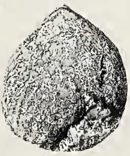
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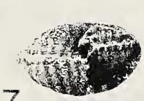
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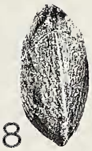
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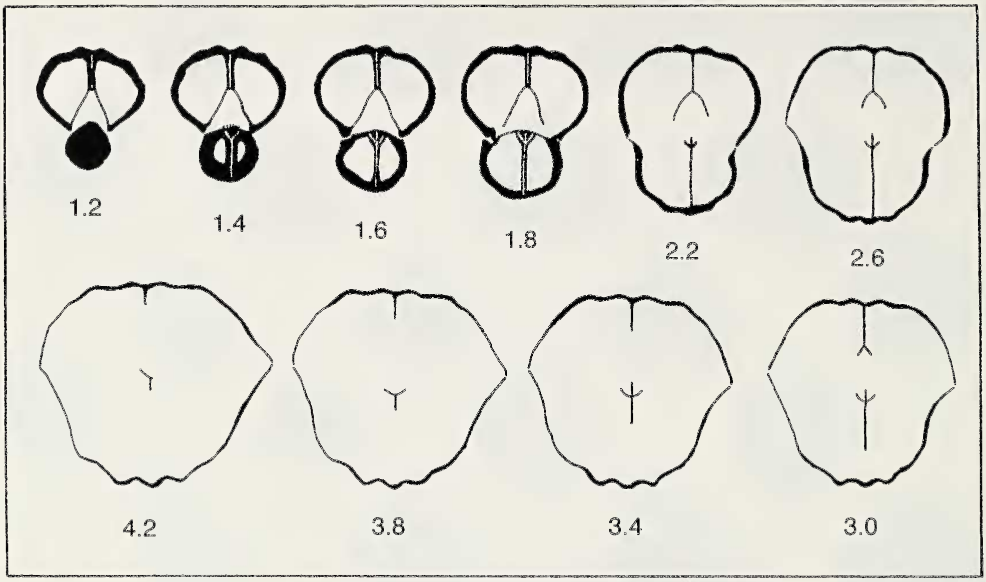

Fig. 9.—Transverse serial sections of *Stenoscisma* sp., GSC 115608, × 2.5. Numbers refer to distance in millimeters from ventral beak.

swollen costellae clearly attest to its generic affinities. However, these few poor, incomplete specimens do not allow specific assignment.

Distribution.—GSC locality 56430 (two ventral valves and one dorsal valve).

Order Pentamerida Schuchert and Cooper, 1931
Superfamily Stenoscismatoidea Oehlert, 1887
Family Stenoscismatidae Oehlert, 1887
Genus *Stenoscisma* Conrad, 1839
Stenoscisma sp.
(Fig. 8.1–8.4, 9)

Description.—This description is based on four specimens, including two complete shells, one ventral valve, and one dorsal valve. One complete specimen was sectioned and is illustrated in Figure 9. The largest complete shell is illustrated in Figure 8. The beak of this weathered specimen was ground down to confirm the presence of a spondylium.

Medium size, moderately to strongly transverse, strongly inequivalved; ventral flanks concave, marked by about three coarse, subangular plicae and possibly a fourth much weaker one; ventral umbonal region smooth; fold and sulcus well developed and marked by two or three strong, angular plicae and up to two much weaker parietal plicae; dorsal valve strongly inflated with convex flanks and ornament complementary to opposite valve.

Ventral interior with deep spondylium elevated well above floor; teeth small, blunt; septum duplex extending anterior to spondylium.

Dorsal interior with short, wide-set sockets; fimbriate cardinal process supported by short, slightly convex hingeplate and long, high median septum; camarophorium narrow, concave, moderately long, extending forward well anterior to dorsally attached portion of septum, with short, low intercamarophorial plate; crura not observed.

Comments.—The few poor specimens of this species do not allow precise identification. We have not been able to find mature individuals of another species of this genus similar in size and proportions to this Canadian species. *Stenoscisma mutabilis* (Chernyshev, 1902) from the Lower Permian of Russia is a highly variable species, some smaller unusually transverse individuals of which might be generally similar in outline and ornament to this Arctic species.

Distribution.—GSC locality 60194 (three specimens); GSC locality 56430A (one poor ventral valve).

Family Atriboniidae Grant, 1965
Subfamily Psilocamarinae Grant, 1965
Genus *Careoseptum*, **new genus**

Type Species.—Careoseptum septentrionalis, n. sp.

Derivation of Name.—From the Latin *careo*, without or lacking; and *septum*, partition.

Diagnosis.—Small, strongly biconvex; flanks smooth; fold and sulcus rounded, smooth, or with weak median rib; median septa lacking or vestigial in both valves; intercamarophorial plate lacking; hingeplate complete in mature shell, forming septalium with camarophorium.

Comments.—The lack of a dorsal septum makes this genus unique for the superfamily Stenoscismatoidea. The absence of an intercamarophorial plate places it in the family Atriboniidae, subfamily Psilocamarinae. Within this subfamily *Careoseptum* is externally similar only to the genus *Psilocamara* Grant, 1965, described from the Moscovian of Texas and Missouri. Internally, the two genera are greatly different.

Distribution.—Lower Moscovian of Arctic Canada.

Species Assigned.—Known only from the type species.

Careoseptum septentrionalis, **new species**
(Fig. 8.5–8.16, 10)

Holotype.—Figures 8.9–8.12, GSC 115598, from GSC locality C-5202.

Paratypes.—Figures 8.5–8.8, GSC 115597, from GSC locality 56430; Figures 8.13–8.16, GSC 115599, from GSC locality 56430; Figure 10A, GSC 115609, 10B, GSC 115610.

Description.—Medium size, outline subovate, strongly inequivalved; fold and sulcus absent posteriorly, strongly produced anteriorly, rounded, smooth, or with weak median rib; lateral slopes smooth; stolidium not apparent; shell matter thickened posteriorly.

Ventral valve weakly convex; umbonal region subtending an angle greater than 90 degrees; beak small, subangular, projecting slightly posterior to dorsal valve; foramen small, rounded; delthyrium apparently open; spondylium supported by thick callus posteriorly, free anteriorly; teeth broad, blunt.

Dorsal valve thick, evenly convex on flanks; fold originating in posterior third to half of valve; umbonal region slightly swollen, compressed laterally; septum lacking; camarophorium unsupported except at posterior margin, covered posteriorly; intercamarophorial plate lacking; crura not observed.

Measurements.—See Table 10.

Diagnosis.—Same as for the genus.

Comments.—The authors know of no other species internally similar to *Careoseptum septentrionalis*.

Table 10.—*Measurements (in millimeters) of the types of* Careospetum septentrionalis, *n. sp.*

GSC number	Locality	Length	Width	Thickness
115597	56430	10.6	10.7	8.1
115598	C-5202	9.6	9.0	6.4
115599	56430	9.5	8.5	6.5

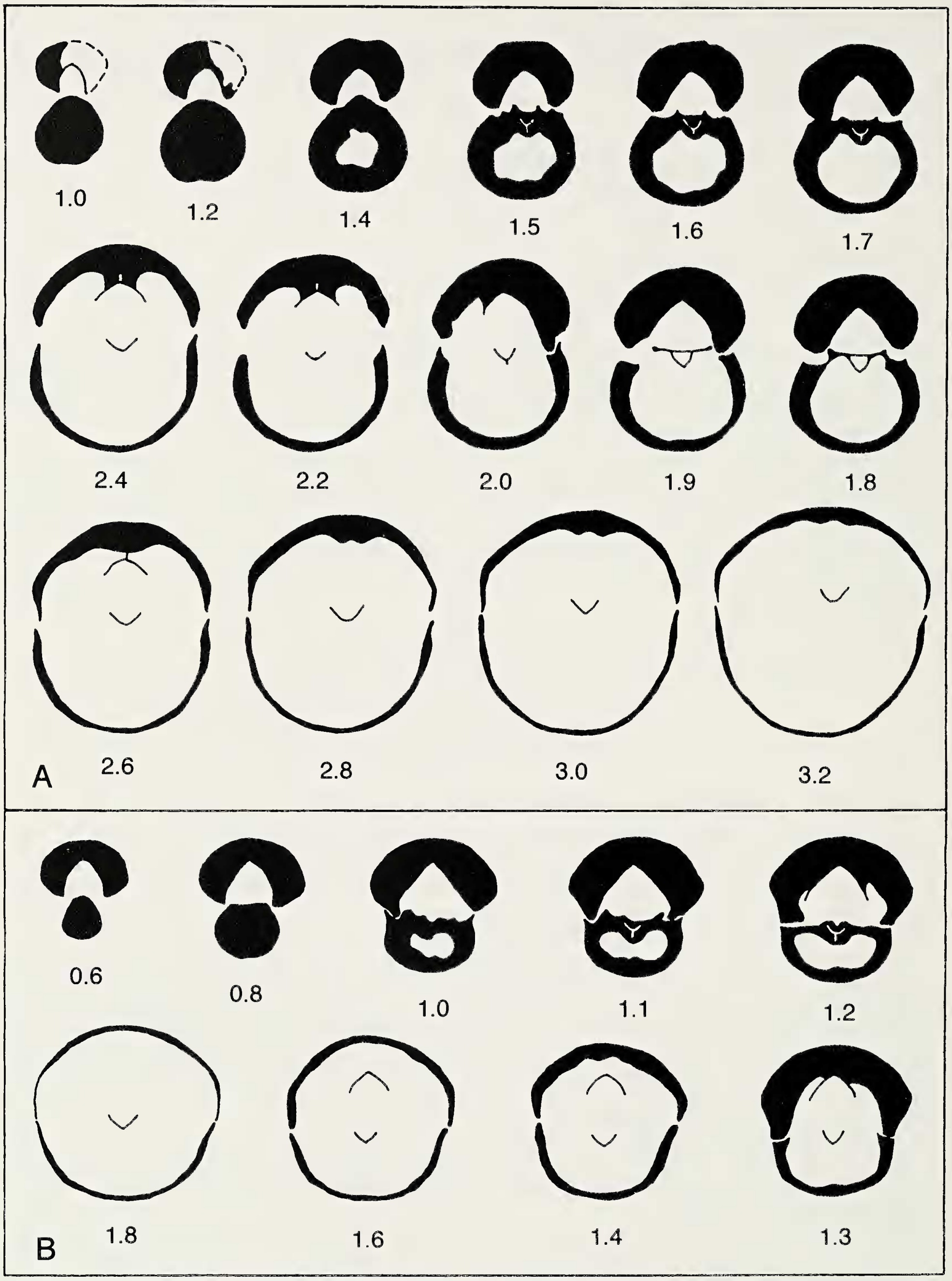

Fig. 10.—Transverse serial sections of *Careoseptum septentrionalis* n. gen. n. sp. Numbers refer to distance in millimeters from ventral beak. A. Large mature specimen, GSC 115609, × 4. B. Small specimen, GSC 115610, × 5.

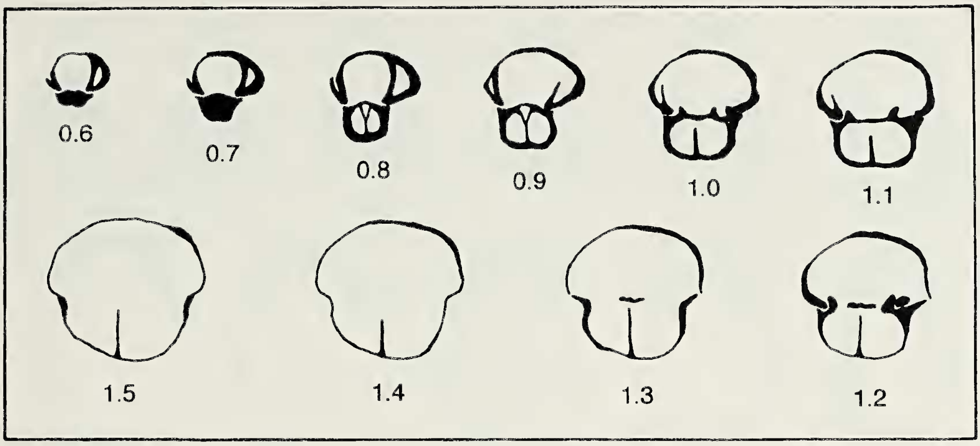

Fig. 11.—Transverse serial sections of *Cenorhynchia* sp., GSC 115611, × 5. Numbers refer to distance in millimeters from ventral beak.

Distribution.—GSC locality 56430 (eight specimens); GSC locality C-5202 (two specimens).

Order Rhynchonellida Kuhn, 1949
Superfamily Rhynchonelloidea Gray, 1848
Family Wellerellidae Likharev, 1956
Genus *Cenorhynchia* Cooper and Grant, 1976
Cenorhynchia sp.
(Fig. 8.17–8.20, 11)

Description.—Medium size for genus, unequally biconvex; outline rounded subtrigonal, lateral profile subelliptical; anterior or posterior profile subelliptical; umbonal region moderately broad, subtending an umbonal angle of about 90 degrees; fold and sulcus moderately developed and moderately wide; flanks of both valves smooth; fold and sulcus with few strong plicae only in anterior third of valves.

Ventral valve moderately convex in lateral profile; beak slightly incurved, small; deltidial plates not observed; foramen not observed; sulcus originating anterior to midlength; sulcus with two strong, sounded plicae on tongue; interior with stout, short, medially concave dental plates.

Dorsal valve with flattened umbonal region; flanks moderately convex, sloping steeply to lateral margins; fold originating anterior to midlength, rising little above lateral slopes, with three strong, rounded plicae confined to anterior third of valve; interior with complete hingeplate covering short septalium; median septum long, very high, nearly in plane of lateral commissure; sockets wide, defined by high socket ridges; crura not observed.

Comments.—This late Bashkirian or early Moscovian Arctic species is similar in its proportions and ornament to *Cenorhynchia saginata* Cooper and Grant, 1976, and *Cenorhynchia triangulata* Cooper and Grant, 1976, from the Permian of west Texas. It differs from the former in its larger size and complete lack of lateral ribbing. *Cenorhynchia triangulata* is less similar to this Arctic species with its inflated dorsal umbo, obscure lateral ribbing, and laterally compressed ventral beak.

Distribution.—GSC locality 56430 (three specimens, one sectioned).

Genus *Phrenophoria* Cooper and Grant, 1969

?*Phrenophoria* sp.

(Fig. 15.20–15.24)

Comments.—A single complete specimen externally similar to the genus *Phrenophoria* Cooper and Grant was not sectioned. Dental plates and a strong dorsal median septum are clearly present which supports this generic assignment but the lack of other internal details prevents certain generic placement. A single disarticulated dorsal valve is nearly identical to that of the complete specimen but adds no additional information concerning morphology.

Distribution.—GSC locality 60194 (two specimens).

Family uncertain

Genus *Exlaminella*, **new genus**

Type Species.—*Exlaminella insolita*, n. sp.

Derivation of Name.—From the Latin *ex*, without; *lamina*, plate; and *ella*, feminine diminutive.

Diagnosis.—Small, unequally biconvex; outline rounded subtrigonal to subovate; flanks smooth; fold and sulcus with plicae confined to anterior half of valves; interior lacking dental plates or dorsal septum; hingeplate divided, crura falcifer; shell posteriorly thickened in both valves.

Comments.—This genus is unusual in its lack of lateral ribbing and internal plates. The latter feature is found in the Permian genera *Iotina* Cooper and Grant, 1976, and *Ptilotorhynchus* Cooper and Grant, 1976, where the dental plates are fused or suppressed. Both of these genera have strong ribbing on the flanks and much different growth form. *Hemileurus* Cooper and Grant, 1976, also Permian, possesses a similar dorsal interior and ribbing confined to the anterior half of the valves. The ventral interior is conventional with long, slender dental plates. Nevertheless, *Hemileurus* is more likely related to *Exlaminella* than the other Permian genera if growth form, ornament, and dorsal interior are of paramount importance in the phylogeny of this group. In the meantime, we cannot definitely assign this new genus to any known family.

Species Assigned.—Monotypic.

Stratigraphic Range.—Late Bashkirian or early Moscovian of Arctic Canada.

Exlaminella insolita, **new species**

(Fig. 8.21–8.28, 12)

Holotype.—Figures 8.25–8.28, GSC 115602, from GSC locality 56430.

Paratypes.—Figures 8.21–8.24, GSC 115601, from GSC locality C-5202; Figure 12A, GSC 115612, from GSC locality C-5202; Figure 12B, GSC 115613, from GSC locality C-5202.

Description.—Ventral valve weakly convex; sulcus originating at about midlength, with two strong subangular plicae anteriorly; umbonal region moderately broad, subtending an angle of 90 degrees or more; beak small, slightly incurved; foramen not observed; delthyrium not observed; ventral interior with thick shell matter but with no indication of dental plates.

Dorsal valve moderately convex in umbonal region, sloping steeply to lateral margins; fold originating near or posterior to midlength, rising moderately to high, marked by three short, strong, rounded plicae anteriorly; dorsal interior with thick callus deposits posteriorly; hingeplate divided; crura falcifer, remaining in plane of lateral commissure; low, thick median ridge variably developed.

Measurements.—See Table 11.

Diagnosis.—Same as for genus.

Comments.—Externally this species is similar in size and growth form to the

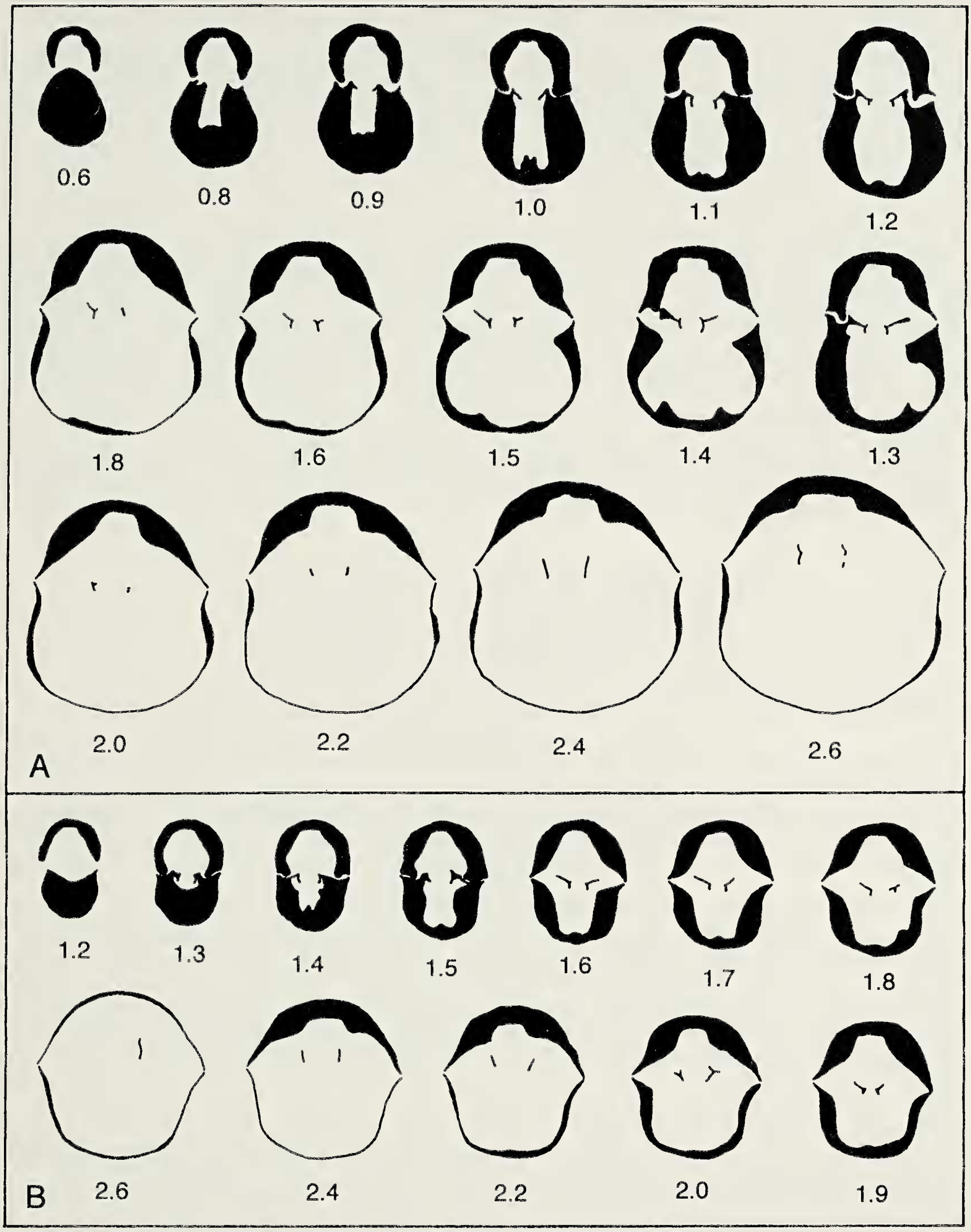

Fig. 12.—Transverse serial sections of *Exlaminella insolita* n. gen. n. sp. Numbers refer to distance in millimeters from ventral beak. A. Large mature paratype, GSC 115612, × 4. B. Juvenile paratype, GSC 115613, × 4.

Table 11.—*Measurements (in millimeters) of* Exlaminella insolita, *n. gen. n. sp. from the lower Hare Fiord Formation.*

GSC number	Locality	Length	Width	Thickness
115601	C-5202	8.4	9.3	6.5
115602	56430	9.9	9.7	8.0

stenoscismatoid genus *Careoseptum* n. gen. and differs externally only in the possession of the short anterior plicae in the fold and sulcus. *Careoseptum septentrionalis* n. gen. n. sp., the type and only species, may have a weak single plica in the sulcus but never has two as does *Exlaminella insolita*. Internally the two species are very different. *Cenorhynchia* sp. is also externally similar to *Exlaminella insolita* in growth form, size, and ornament. The former differs internally in its high dorsal septum and stout dental plates.

Distribution.—GSC locality 56430 (two specimens); GSC locality C-5202 (three specimens, two sectioned).

Family Petasmatheridae Cooper and Grant, 1976
Genus *Elassonia* Cooper and Grant, 1976
?*Elassonia sverdrupensis*, **new species**
(Fig. 8.29–8.40, 13)

Holotype.—Figures 8.29–8.32, GSC 115603, from GSC locality 56430.

Paratypes.—Figures 8.33–8.40, GSC 115604, 115605, and 115614, from GSC locality 56430.

Description.—Small, flattened, nearly equally biconvex, outline rounded subtrigonal to guttate; lateral and anterior profiles lenticular; fold and sulcus lacking; anterior commissure rectimarginate; both valves completely costate to beaks with numerous bifurcating, intercalating, or simple costae; umbonal regions evenly elongated, usually subtending an angle of less than 90 degrees, margins slightly compressed.

Ventral valve slightly thicker than dorsal valve, weakly and evenly convex in lateral profile; venter weakly convex or flattened; flanks sloping nearly normal to lateral margins, forming subangular beak ridges; beak small, undifferentiated from umbo, suberect; foramen not observed; interior with short, medially concave, thin dental plates.

Dorsal valve more evenly rounded and slightly compressed laterally in umbonal region; dorsum anteriorly flattened or with faint sulcus; otherwise similar in convexity to opposite valve; interior with very short septalium supported by stout, moderately long median septum; hingeplate divided or undivided; crura falcifer, thin, curving ventrad.

Measurements.—See Table 12.

Diagnosis.—This species can be differentiated by small size, thin profile, triangular outline, the lack of a fold and sulcus, and bifurcating costae.

Comments.—These specimens, lacking a fold and sulcus, resemble juvenile specimens of much larger species. However, we are convinced that these 14 specimens are mature individuals because of the uniformity in size of the specimens.

Assignment of this unusual species to the Permian genus *Elassonia* Cooper and Grant is arbitrary. We have little doubt that it represents an undescribed genus but the indifferent preservation of this collection and lack of pristine specimens inhibits us from proposing one.

Distribution.—GSC locality 56430 (14 specimens, eight complete or nearly complete, two sectioned).

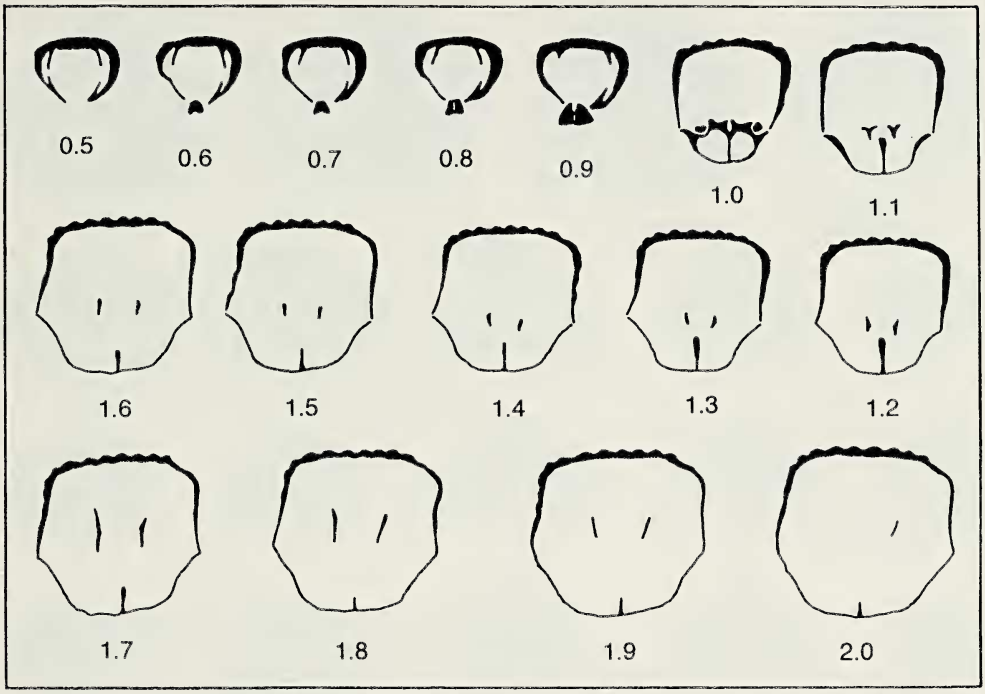

Fig. 13.—Transverse serial sections of ?*Elassonia sverdrupensis* n. sp., paratype, GSC 115614, × 5. Numbers refer to distance in millimeters from ventral beak.

Family Allorhynchidae Cooper and Grant, 1976
Genus *Hemileurus* Cooper and Grant, 1976
?*Hemileurus* sp.
(Fig. 8.41–8.48, 14)

Description.—Small, almost equally biconvex, outline longitudinally subovate; lateral and anterior profiles thinly lenticular; fold and sulcus lacking; anterior commissure rectimarginate; umbonal regions smooth, anterolateral margins with weak costellae; beak ridges rounded.

Ventral valve slightly thicker than dorsal valve, evenly convex; umbonal region slightly extended, subtending an angle of about 90 degrees; beak small, nearly straight, inconspicuous; posterolateral margins slightly compressed in some specimens; interior with short, thin, straight dental plates; muscle field deeply incised.

Dorsal valve evenly convex, with slightly flattened dorsum anteriorly; umbonal region slightly swollen, weakly compressed laterally; interior with divided hingeplate; median septum lacking; crura falcifer, not rising but remaining in plane of lateral commissure.

Comments.—These small specimens, lacking any indication of a fold and sulcus, are probably juveniles of the genus *Hemileurus* Cooper and Grant, agreeing

Table 12.—*Measurements (in millimeters) of* ?Elassonia sverdrupensis, *n. sp. from GSC locality 56430 of the lower Hare Fiord Formation.*

GSC number	Length	Width	Thickness
115603	10.5	9.5	5.3
115604	10.1	9.8	5.0
115605	9.5	9.9	4.4

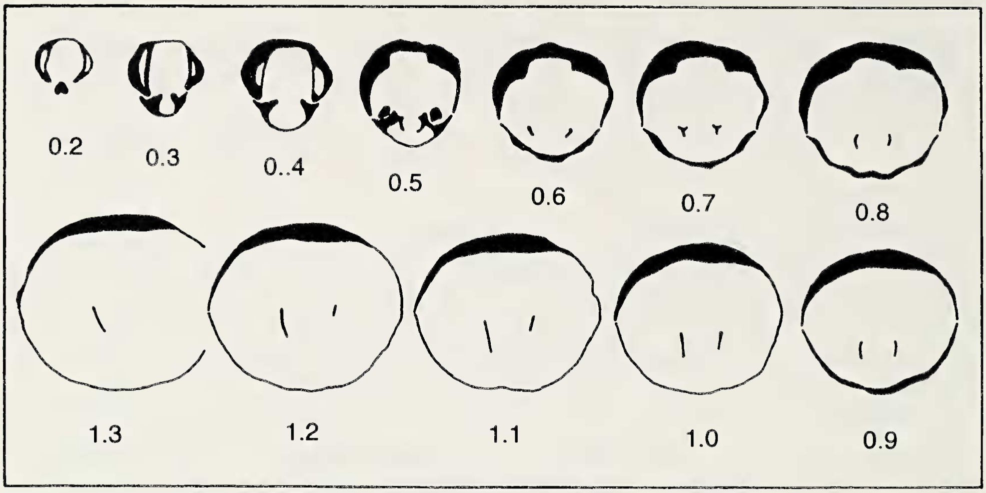

Fig. 14.—Transverse serial sections of ?*Hemileurus* sp., GSC 115615, × 8. Numbers refer to distance in millimeters from ventral beak.

in most respects with the type species of that genus, except for their lack of a fold and sulcus and having more numerous costellae near the margins. They are not similar to any other species from the Hare Fiord Formation.

Distribution.—GSC locality 56430 (five specimens, one sectioned).

Family Tetracameridae Likharev, 1958
Genus *Septacamera* Stepanov, 1937
Septacamera sp.
(Fig. 15.1–15.4)

Description.—This description is based on a single, nearly complete specimen.

Medium size for genus, strongly inequivalved; outline and lateral profile rounded subtrigonal, anterior profile subquadrate; anterior surface flattened; anterior commissure uniplicate with large ventral tongue; fold and sulcus moderately well developed, originating in umbonal region of both valves; plicae simple, subangular, numbering three in sulcus, four on fold, and five or six on each lateral slope, lateral two or three very weak.

Ventral valve gently convex with sharply geniculated tongue in sulcus; beak and foramen not preserved.

Dorsal valve thick, strongly inflated with weakly convex dorsum; lateral slopes bent sharply ventrad with flattened sides.

Interior not observed.

Comments.—This species is similar in size, lateral profile, and ornament to *Septacamera kutorgae* (Chernyshev, 1902) from the Lower Permian of Russia. It differs in having a more triangular outline, a more quadrate anterior profile, and a flatter fold.

Distribution.—GSC locality 60194 (one specimen).

Family Pontisiidae Cooper and Grant, 1976
Genus *Antronaria* Cooper and Grant, 1976
Antronaria annosa, **new species**
(Fig. 15.5–15.19, 16)

Holotype.—Figures 15.5–15.9, GSC 115617, from GSC locality 56430.

Paratypes.—Figures 15.10–15.14, GSC 115618, from GSC locality 56430; Figures 15.15–15.19 and 16, GSC 115619, from GSC locality 60194.

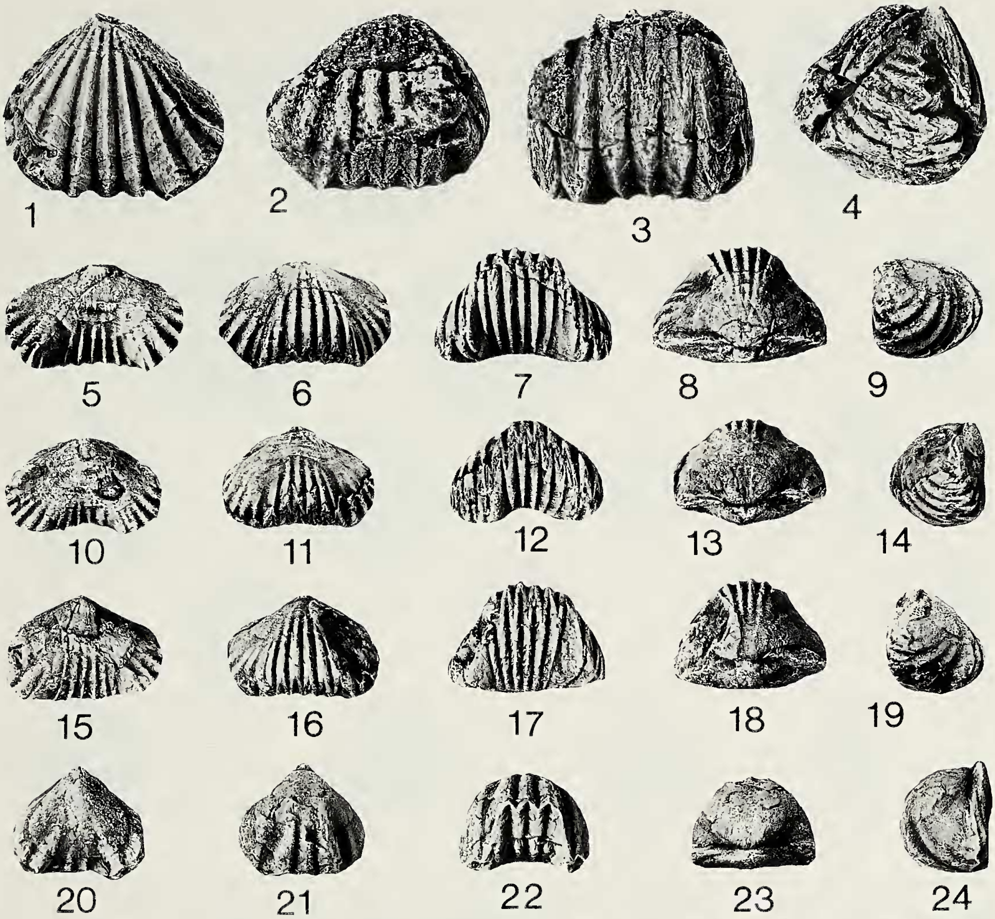

Fig. 15.—Rhynchonelloids. 15.1–15.4, *Septacamera* sp., ventral, dorsal, anterior, and lateral views, GSC 115616, × 1. 15.5–15.19, *Antronaria annosa* n. sp., ventral, dorsal, anterior, posterior, and lateral views of three specimens, including the holotype (15.5–15.9), GSC 115617–115619, respectively, × 1. 15.20–15.24, ?*Phrenophoria* sp., ventral, dorsal, anterior, posterior, and lateral views, GSC 115620, × 1.

Description.—Larger than average for genus, unequally biconvex; outline subelliptical; umbonal region very broad, subtending an angle of 135 degrees or more; both valve margins near posterior commissure compressed; fold and sulcus wide, well developed, originating in posterior half or third of valves; anterior commissure strongly uniplicate; beak short, inconspicuous, scarcely extending posterior to opposite valve; deltidial plates not observed; umbonal regions smooth, remainder of valves costate; flanks with five to seven subangular costae, originating well anterior to umbonal region; fold and sulcus with five to seven subangular costae.

Ventral valve weakly to moderately convex or flattened in lateral profile, flat or concave in anterior profile; umbonal region slightly swollen, flanks flattened or weakly concave; sulcus originating posterior to midvalve, in anterior portion of umbonal region; sulcus rounded, evenly curving dorsad, not geniculate; dental plates strong, diverging anteriorly, of moderate length.

Dorsal valve rounded subtrigonal in lateral profile, strongly convex in anterior profile; umbonal region laterally defined by concave flexures; flanks convex, curving steeply to lateral margins; fold originating near midlength, well defined and elevated anteriorly, flattened or weakly convex in anterior profile; costae on fold not depressed as in type species; interior with flattened, complete hingeplate;

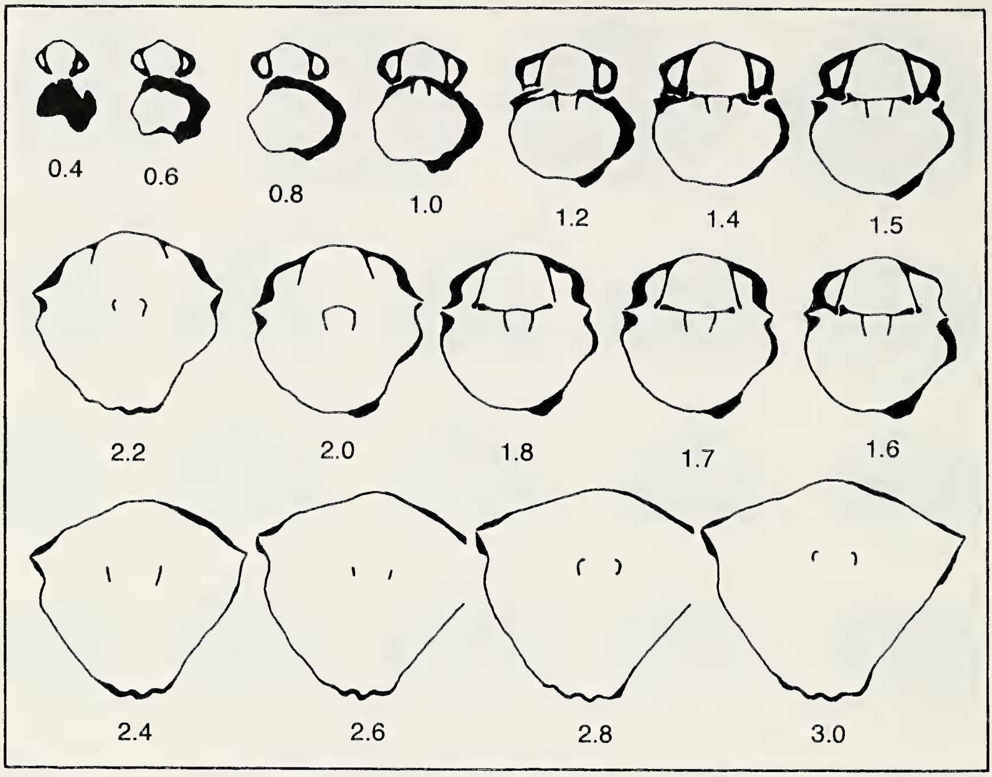

Fig. 16.—Transverse serial sections of *Antronaria annosa* n. sp., paratype GSC 115619, × 2.5. Numbers refer to distance in millimeters from ventral beak.

crural bases attached to dorsal surface of hingeplate, slightly convergent, extending forward in plane of commissure as long, slender, medially concave crura.

Measurements.—See Table 13.

Diagnosis.—This species is characterized by evenly rounded lateral margins, inconspicuous ventral beak, smooth umbonal regions, and lack of depressed costae on the fold.

Comments.—These specimens are similar to those illustrated by Cooper and Grant (1976) of *Antronaria transversa* (King) from the Wolfcampian of Texas. They differ in minor details, having more evenly rounded lateral margins, a smaller ventral beak, the ribbing originates more anteriorly, and they lack depressed medial ribs on the fold.

This Arctic species is the first reported in the literature from strata older than the early Permian.

Table 13.—*Measurements (in millimeters) of* Antronaria annosa *n. sp. (King).*

GSC number	Locality	Length	Width	Thickness
115617	56430	16.2	23.5	14.9
115618	56430	14.4	20.6	13.2
115619	60194	15.5	20.8	13.7

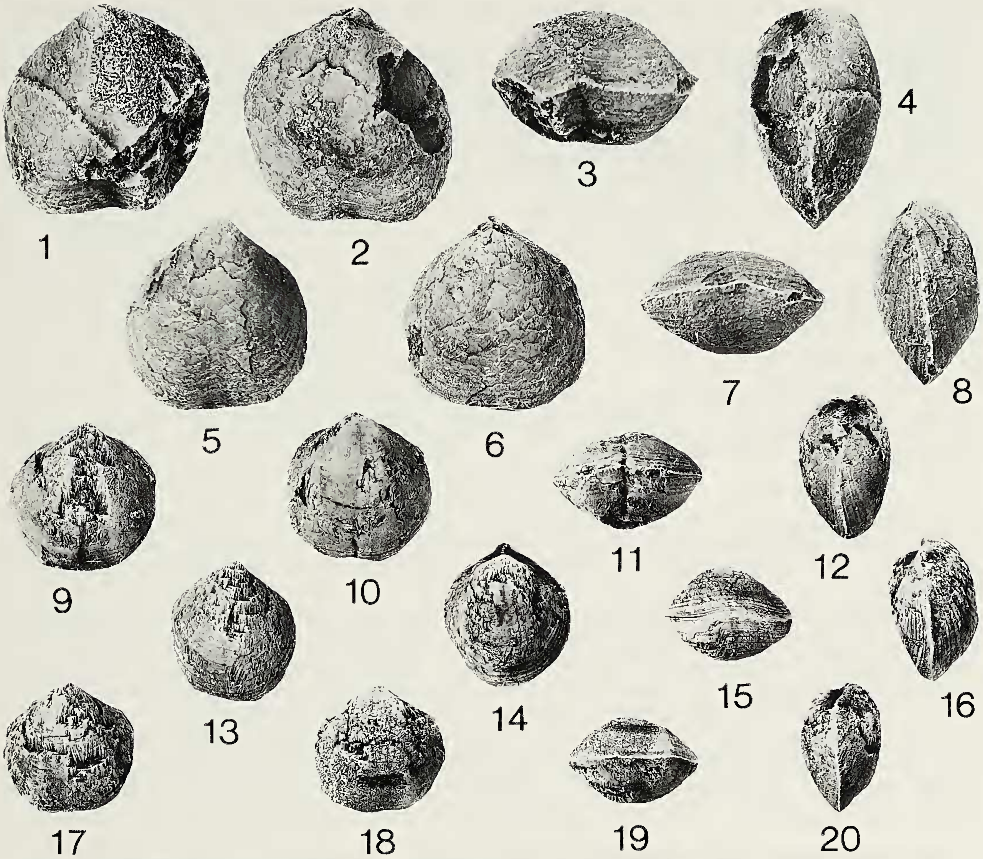

Fig. 17.—Athyridoids. 17.1–17.8, *Camarium nuperum* n. sp., ventral, dorsal, anterior, and lateral views of two specimens, including the holotype (17.5–17.8), GSC 115621 and 115622, × 3. 17.9–17.20, *Nucleospira aquilonaris* n. sp., ventral, dorsal, anterior, and lateral views of three specimens, including the holotype (17.9–17.12), GSC 115623–115625, respectively, × 2.

Distribution.—GSC locality 56430 (four specimens); GSC locality 60194 (two specimens, one sectioned).

Order Athyridida Boucot, Johnson, and Staton, 1965
Suborder Athyridina Boucot, Johnson, and Staton, 1965
Superfamily Athyridoidea Davidson, 1881
Family Meristellidae Waagen, 1883
Subfamily Meristinae Hall and Clarke, 1895
Genus *Camarium* Hall, 1859
Camarium nuperum, **new species**
(Fig. 17.1–17.8, 18)

Holotype.—Figures 17.5–17.8, GSC 115621, from GSC locality 56430.

Paratypes.—Figures 17.1–17.4, GSC 115622, from GSC locality 564530; Figure 18, GSC 115626, from GSC locality 56430.

Description.—Small, subequally biconvex, outline subovate; maximum width attained near mid-length; lateral and anterior profiles lenticular; fold lacking but shallow sulcus present on anterior half

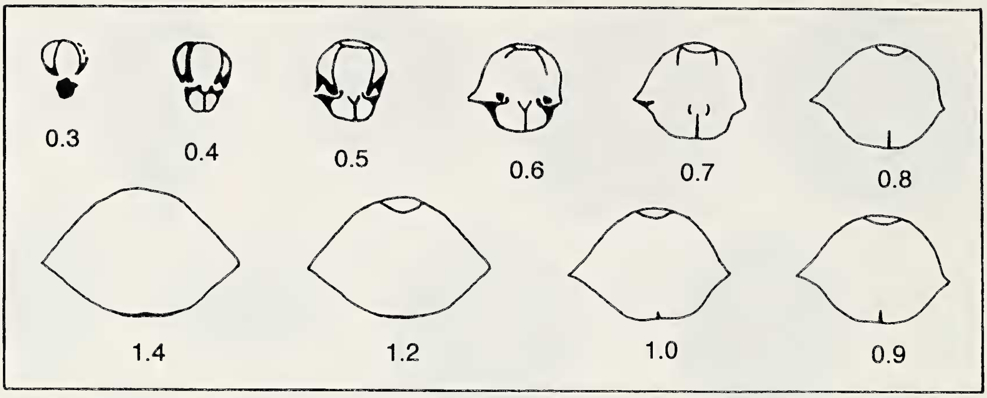

Fig. 18.—Transverse serial sections of *Camarium nuperum* n. sp., GSC 115626, × 6. Numbers refer to distance in millimeters from ventral beak.

of ventral valve producing slight emargination; posterolateral margins slightly compressed; anterior commissure nearly rectimarginate with slight medial dorsal flexure; surfaces smooth except for fine growth lines.

Ventral valve with slightly swollen umbonal region with moderately broad posterolateral extremities which subtend an angle greater than 90 degrees; beak small, incurved; foramen not observed; venter and lateral slopes evenly and moderately convex; sulcus originating near midlength, becoming moderately deep and rounded near anterior margin; interior with medially concave dental plates and low, short, convex shoelifter process which originates in umbonal region; teeth broad, blunt.

Dorsal valve with sides of umbonal region slightly compressed, flanks and dorsum evenly convex near midvalve, dorsum slightly flattened anteriorly; interior with septalium supported by high median septum which extends forward nearly as far as shoelifter process in opposite valve; crura and spiralia not observed.

Measurements.—See Table 14.

Diagnosis.—This species can be differentiated by its small size and distinct ventral sulcus.

Comments.—Amsden (1968) validated the genus *Camarium* Hall after discovering that it lacks mystrochial plates, unlike the genus *Merista* Suess which has them. The type species of *Camarium*, *C. typa* Hall, is from the Upper Silurian of the eastern United States. Carter (1967) described an anachronistic species of *Camarium* as *Merista maccullochensis* from the Lower Mississippian of Texas. Campbell and Engel (1963) also reported *Merista* sp. in the Tournaisian of New South Wales. All other reports of *Camarium* are from Middle Devonian or older strata.

Camarium nuperum n. sp. is similar to the above-mentioned species of Tournaisian age, differing only in the presence of a distinct ventral sulcus.

Distribution.—GSC locality 56430 (four specimens, one sectioned).

Table 14.—*Measurements (in millimeters) of the types of* Camarium nuperum, *n. sp., from GSC locality 56430.*

GSC number	Length	Width	Thickness
115621	9.4+	9.0	6.1
115622	8.2	8.1	4.9

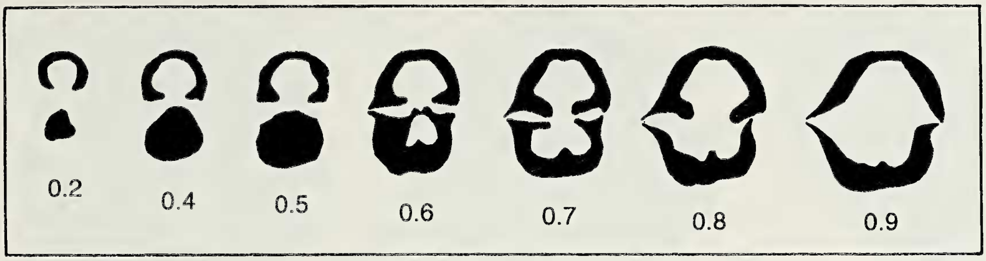

Fig. 19.—Transverse serial sections of *Nucleospira aquilonaris* n. sp., GSC 115627, × 5. Numbers refer to distance in millimeters from ventral beak.

Family Nucleospiridae Davidson, 1881
Genus *Nucleospira* Hall, 1859
Nucleospira aquilonaris, **new species**
(Fig. 17.9–17.20, 19)

Holotype.—Figures 17.9–17.12, GSC 115623, from GSC locality 56430.

Paratypes.—Figures 17.13–17.20, two shells, GSC 115624 and 115625, from GSC locality 56430; Figure 19, GSC 115627, from GSC locality 56430.

Description.—Small, subequally and moderately biconvex; outline subovate to weakly subpentagonal; greatest width near midlength; anterior margin rounded to slightly emarginate; lateral and anterior profiles lenticular; surfaces smooth except for irregularly spaced growth varices; micro-ornament not preserved; fold lacking; sulcus lacking or weak, shallow sulcus present on some ventral valves; anterior commissure rectimarginate to weakly uniplicate; shell substance very thick.

Ventral valve moderately inflated, evenly convex in lateral profile; umbonal region broad, slightly compressed at margins; beak small, acute, straight, projecting slightly posterior to opposite valve; foramen triangular; interarea acutely triangular, flattened to weakly concave; sulcus, if present, shallow, weak, originating in anterior half of valve; interior with large, blunt, unsupported teeth and low, weak median ridge.

Dorsal valve with slightly swollen umbonal region defined laterally by concave flexures and compressed lateral margins; dorsum evenly convex or slightly flattened anteriorly; dorsal interarea not detected; interior with high bilobed hingeplate and thick myophragm; other details not observed.

Measurements.—See Table 15.

Diagnosis.—This species is characterized by its thickened shell, well-developed ventral beak, flattened dorsum, and moderately inflated lateral profile.

Comments.—Upper Carboniferous *Nucleospira* are very rare. *Nucleospira superata* Easton, 1962, from the Cameron Creek Formation (Lower Morrowan) of Montana, is the only other Upper Carboniferous species we can find in the literature and is of very early Late Carboniferous age, much older than the Hare Fiord species. The latter is more transverse than *N. aquilonaris*, with an inconspicuous ventral beak, and the lateral slopes are more flattened in anterior profile.

Brunton (1984) also failed to find other evidence of Upper Carboniferous species of this genus. Cooper and Grant (1976) state that it generally had been

Table 15.—*Measurements (in millimeters) of* Nucleospira aquilonaris, *n. sp., from GSC locality 56430.*

GSC number	Length	Width	Thickness
115623	9.7	9.9	6.6
115624	9.6	8.7	6.3
115625	8.5	8.6	5.8

believed that *Nucleospira* became extinct at the end of the Early Carboniferous but they described a typical species, *N. cunctata*, from the Lower Permian of west Texas. The reduced ventral median ridge found in *N. aquilonaris* is also seen in this Permian species.

Distribution.—GSC locality 56430 (40 specimens, two sectioned).

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Ambocoelioidea George, 1931
Family Ambocoeliidae George, 1931
Genus *Crurithyris* George, 1931
Crurithyris cf. *tschernyschewi* Likharev, 1939
(Fig. 20.18–20.21)

1902 *Ambocoelia planoconvexa* Shumard: Chernyshev, p. 196, pl. 20, fig. 1; pl. 49, fig. 7.
1939 *Ambocoelia (Crurithyris) tschernyschewi* Likharev, p. 108, pl. 27, fig. 5.

Description.—Hingeline somewhat shorter than width; ventral valve moderately convex; greatest thickness at or just posterior to hingeline; ventral umbo narrow and weakly incurved, beak not overhanging hinge plane; area low and concave under beak, clearly restricted, triangular; ventral sinus absent but valve flattened along midline; dorsal valve almost flat or slightly convex with shallow groove anteriorly; area low, triangular, well delimited; surface smooth, with few irregular coarse growth varices anteriorly; dental adminicula in ventral valve absent; other internal features not observed.

Diagnosis.—A small, transversely ovate *Crurithyris* with greatest width no more than ten mm.

Comments.—The general shape, size, and characters of the ventral valve allow us to conclude that this species is very close to or identical with *Crurithyris tschernyschewi* Likharev. However, our restricted material, consisting of only one complete shell and one ventral valve, are both poorly preserved and compel us to avoid a certain definition. The other nearest known species to ours is *Crurithyris expansa* Dunbar and Condra, 1932, from the Wabaunsee Group (Permian) in Nebraska. This species differs in its much more incurved ventral umbo with the apex lying approximately in the plane of the dorsal valve. *Crurithyris planoconvexa* (Shumard, 1855), from the Pennsylvanian and Lower Permian of North America and Europe, differs in its much more convex ventral valve with more stout, incurved ventral umbo and much smaller size.

Distribution.—Both specimens are from GSC locality 56430.

Crurithyris sp.
(Fig. 20.22–20.25)

Comments.—A second species of *Crurithyris* was found at GSC locality 56430. This one is characterized by its small size, more rounded outline, more tumid ventral valve, and more flattened dorsal valve than the previously described spe-

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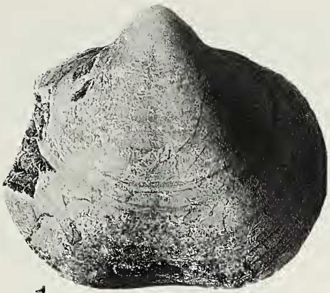
Fig. 20.—Ambocoelioids and martinioids. 20.1–20.17, *Tiramnia walteri* n. sp.; 20.1–20.10, 20.13–20.17, ventral, dorsal, lateral, anterior, and posterior views of three specimens, including the holotype (20.1–20.5), GSC 115628–115630, respectively; 20.11, 20.12, ventral molds showing vascular marks, GSC 115631 and 115632; all × 1. 20.18–20.21, *Crurithyris* cf. *C. tschernyschewi* Likharev, 1939, ventral, dorsal, anterior, and lateral views of a spalled shell, GSC 115633, × 3. 20.22–20.25, *Crurithyris* sp., ventral, dorsal, anterior, and lateral views, GSC 115634, × 3.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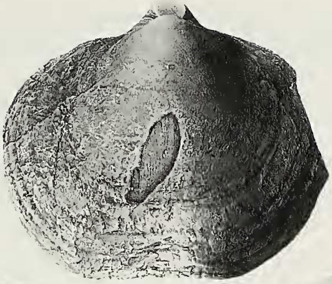
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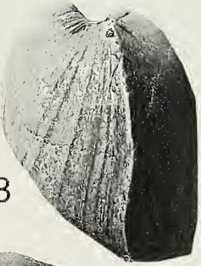
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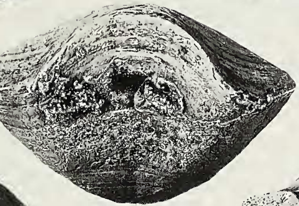
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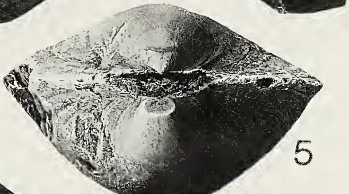
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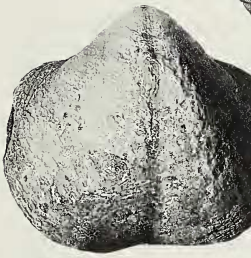
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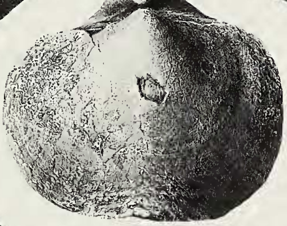
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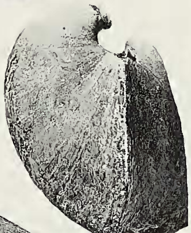
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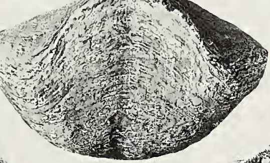
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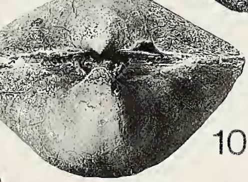
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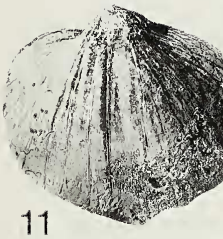
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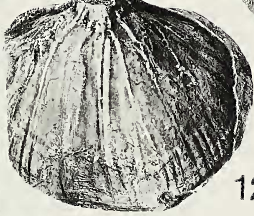
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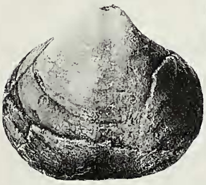
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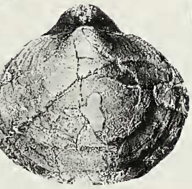
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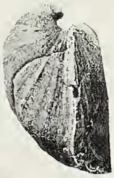
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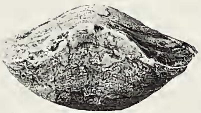
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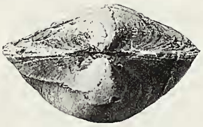
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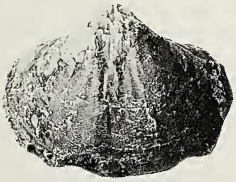
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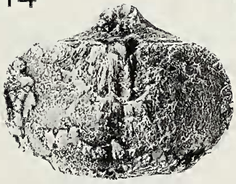
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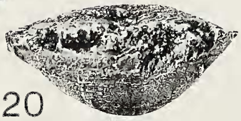
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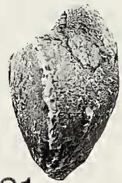
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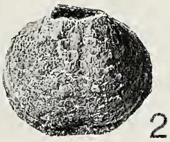
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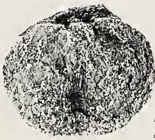
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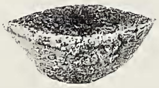
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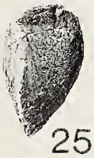
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cies. Precise identification of this species is impossible because of the paucity of specimens, only two shells, one with a broken ventral beak.

Superfamily Martinioidea Waagen, 1883
Family Martiniidae Waagen, 1883
Subfamily Martiniinae Waagen, 1883
Genus *Tiramnia* Grunt, 1977
Tiramnia walteri, **new species**

(Fig. 20.1–20.17)

Holotype.—GSC 115628, Figures 20.1–20.5, GSC locality 56430.

Paratypes.—GSC 115629 and 115630, Figures 20.6–20.10, 20.13–20.17, same collection as the holotype; GSC 115631 and 115632, Figures 20.11 and 20.12, vascular impressions of two ventral valves; all from GSC locality 56430.

Description.—Medium to large for genus, ventribiconvex, usually wider than long; outline transversely oval to subpentagonal, greatest width attained near or anterior to midlength; ventral valve one and one-half times thicker than dorsal valve; anterior commissure uniplicate; fold and sulcus wide, shallow, and poorly delimited, developed only anteriorly; ornamentation lacking and surface smooth except for growth lines and irregularly spaced growth varices; spalled surfaces may show faint radial striations in front part of some adult specimens.

Ventral valve most convex in umbonal region; beak small, incurved; umbonal region moderately broad, only moderately extended posterior to hingeline; flanks gently convex; sulcus originates obscurely some distance in front of beak as narrow, weak furrow becoming wider and somewhat deeper past midway to front margin, where in some shells its sides slope gently toward faint depression along midline; some variation in shape of sulcus; often furrow is almost obscure and sulcus depression is very softly curved, producing moderate tongue at anterior commissure; hingeline usually little less than half width of shell; ventral interarea small, triangular, moderately high and curved, often obscurely defined, with apical angle of about 115 to 120 degrees; delthyrium open.

Ventral muscle field narrow, fusiform, deeply impressed, located mostly within umbonal region; posterior part of adult valves thickened; vascular impressions distinct, radial, bifurcating anteriorly.

Dorsal valve transversely subovate in outline, slightly thinner than opposite one, with moderately gibbous umbonal region and inconspicuous beak; fold arises obscurely in anterior part of valve and rises to its maximum height at front margin, where it is obscurely delimited; dorsal interarea orthocline, less than one-third height of ventral, with broad, open notothyrium; muscle scars very simple, radially dissected and lightly impressed; other internal details not observed.

Measurements.—See Table 16.

Diagnosis.—This species is characterized by comparatively large size (as much as 40 mm long and 50 mm wide), transversely subovate to subpentagonal outline, longer thicker ventral valve than dorsal, and fold and sulcus only clearly expressed anteriorly.

Comments.—*Tiramnia walteri* n. sp. is similar in general outline to *Martinia*? *triquetra* Gemmellaro, 1899, sensu Grunt and Dmitriev, 1973, from the Nizhneganskaya Subsuite, Murgabian Stage, lower part of the Upper Permian of the southeastern Pamir Mountains. The latter differs from *Tiramnia walteri* n. sp. in having a much longer hingeline and a deeper, more distinctly acute sulcus.

Tiramnia greenlandica Dunbar, 1955, from the Permian Martiniakalk of east

Table 16.—*Measurements (in millimeters) of* Tiramnia walteri, *n. sp. from GSC locality 56430.*

GSC number	Length	Width	Thickness	Hingeline
115628	39.5	43.7	26.5	17.1
115629	35.4	37.5	23.8	23.2
115630	24.7	26.8	14.7	10.4

Greenland, is very similar to young specimens of this new species. Mature forms of *T. walteri* n. sp. differ in being much larger, they mostly have a less stout umbo and a shorter and less curved beak; the sulcus is more obscure posteriorly and lacks angular borders anteriorly.

Distribution.—*Tiramnia walteri* n. sp. is abundant at GSC localities 56430 (37 specimens) and C-4011 (22 specimens). It also occurs at GSC localities 56430A (seven specimens) and C-4084 (seven specimens). A similar or identical species occurs in the Ladrones Limestone of southeastern Alaska.

Tiramnia grunti, **new species**
(Fig. 21.1–21.16)

v.1977 *Tiramnia semiglobosa* Chernyschev, 1902:Grunt, p. 66, pl. 11, fig. 8, 9.
v.1977 *Tiramnia greenlandica* Dunbar, 1955:Grunt, p. 64, pl. 11, fig. 4, 6, non 5.

Holotype.—GSC 115635, Figures 21.1–21.5, from GSC locality 56430.

Paratypes.—GSC 115636–115638, Figures 21.6–21.16, all from GSC locality 56430.

Description.—Small to medium size for genus, moderately to strongly subequally biconvex; outline longitudinally subovate to almost round with dorsal valve often almost same length as opposite valve; hingeline much less than greatest width, often one-third or less; maximum width attained near midlength; fold and sulcus obscure posteriorly and weak or moderately developed anteriorly, where they produce weakly or clearly uniplicate commissure; shell substance very thin; surface almost smooth, rarely with a few visible growth varices near anterior commissure.

Ventral valve moderately to considerably inflated, rounded in outline, with greatest thickness near midlength; umbo short and suppressed; small beak, not extending posteriorly to hingeline; interarea low, catacline, concave, poorly differentiated from flanks; delthyrium wide, forming equilateral triangle and occupying approximately one-half of interarea; deltidial plates narrow; sulcus obscure, shallow, appearing near midlength; some specimens with narrow furrow along midline, which begins on umbo and extends to end of moderately long tongue; ventral interior with narrow, deeply impressed fusiform muscle field surrounded by radial vascular impressions; most prominent vascular impression lies on midline and continues to midlength.

Dorsal valve usually as inflated as opposite valve; outline rounded or subpentagonal with large, slightly tumid umbonal region and small beak protruding posteriorly; dorsal interarea low, narrowly triangular, orthocline with open notothyrium; fold absent or weakly expressed near anterior margin; interior with delicate cardinalia; muscle scars weakly impressed.

Measurements.—See Table 17.

Diagnosis.—This species is characterized by its comparatively small size, rounded outline, almost equidimensional ventral and dorsal valves, prominent dorsal umbo, very weak fold, and moderate or weak sulcus.

Comments.—*Tiramnia grunti* n. sp. varies in such important characteristics as relative length of the dorsal and ventral valves, depth of sulcus, and thickness. Some specimens show extreme variation in one or more of these characters but are united by a multitude of intermediate forms.

Tiramnia grunti n. sp. is most similar to *Martinia*? *corculum* Kutorga, 1842, from the early Permian (Asselian?) near Sterlitamak, Bashkiria, south Urals. The latter differs in being smaller and having a flatter and shorter dorsal valve with an obscure umbo. *Tiramnia greenlandica* (Dunbar, 1955), from the Permian Martiniakalk of east Greenland, differs also in its wider, more subtriangular outline and wider sulcus with rather angular borders.

Distribution.—This is the most numerous species at GSC locality 56430 (144 good specimens plus several hundred disarticulated valves). Six specimens were found at GSC locality 56430A. It is known also, but not described, from the Upper Carboniferous of Cape Chaika, Ugor Peninsula, northern Ural Mountains, Russia, and the Ladrones Limestone of southeastern Alaska.

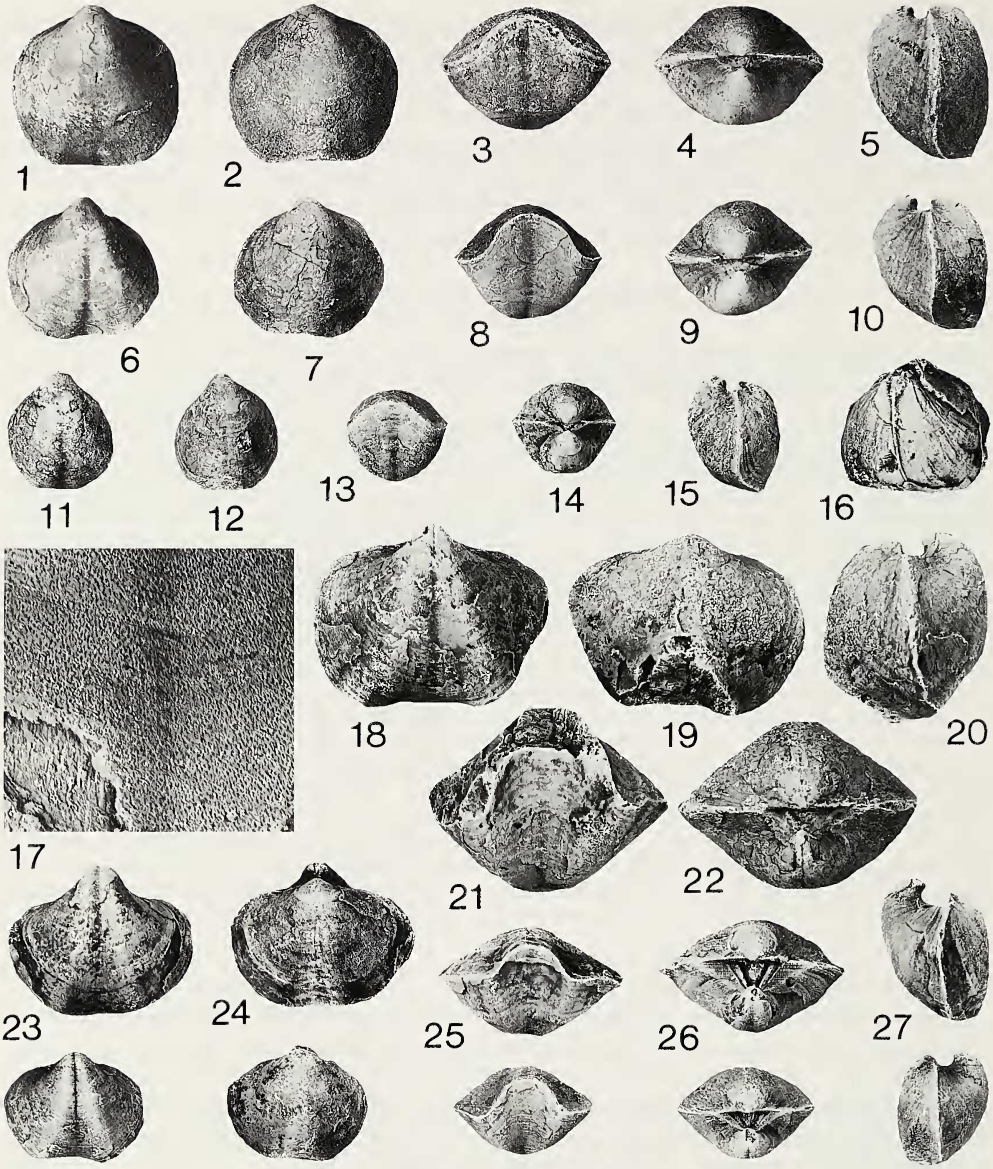


Fig. 21.—Martinioids. 21.1–21.16, *Tiramnia grunti* n. sp.; 21.1–21.15, ventral, dorsal, anterior, posterior, and lateral views of three specimens, including the holotype (21.1–21.5), GSC 115635–115637, respectively; 21.16, mold of ventral interior showing vascular marks, GSC 115638, × 1. 21.17–21.32, ?*Heteraria canadiensis* n. sp.; 21.17, micro-ornament, GSC 115639, × 10; 21.18–21.32, ventral, dorsal, lateral, anterior, and posterior views of three specimens, including the holotype (21.18–21.22), GSC 115640–115642, respectively, × 1.5.

Table 17.—*Measurements (in millimeters) of* Tiramnia grunti, *n. sp. from GSC locality 56430.*

GSC number	Length	Width	Thickness	Hingeline
115635	22.4	22.7	16.6	7.9
115636	20.1	19.9	14.9	8.6
115637	16.7	13.9	12.2	5.8

Genus *Jilinmartinia* Lee and Gu, 1980

?*Jilinmartinia* cf. *J. sokolovi* (Tschernyschew, 1902)

(Fig. 23.1–23.4)

v.1902 *Spirifer sokolovi* Chernyshev, p. 166, pl. 8, fig. 3, pl. 39, fig. 4.
1939 *Spirifer* (*Brachythyris*) *sokolovi* Likharev, p. 107, pl. 27, fig. 3.
1980 *Martinia sokolovi* Kalashnikov, p. 100, pl. 36, fig. 2, 3; textfig. 10.

Discussion.—There is only one specimen of this species from GSC locality 56430. It is a large, completely smooth martiniid closely similar to the lectotype of *Spirifer sokolovi* Chernyshev (1902:pl. 8, fig. 3). The Canadian specimen has almost the same size, general shape, outline, regularly curved ventral valve, and nearly flat dorsal valve as seen in the Uralian specimen from the *Schwagerina* beds (Asselian) of Kazarmensky Kamen Hill near the town of Asha on the Sim River, Ural Mountains.

Comments.—Assignment of this species to the genus *Jilinmartinia* is uncertain because it is based only on external similarity with the type specimen of the type species. The internal morphology of the Chinese and Canadian specimens is unknown.

Kalashnikov (1980) reported *Martinia sokolovi* (Chernyshev) from the Lower Moscovian (Vereyan) and Upper Carboniferous beds of Novaya Zemlya and the Moscovian of north Timan. The specimen illustrated by Kalashnikov is more similar to specimens of *Jilinmartinia laevis* (Likharev, 1939) from the lower Gjelian of the Donets Basin.

Subfamily Eomartiniopsinae Carter, 1994

Genus *Heteraria* Cooper and Grant, 1976

Comments.—Cooper and Grant (1976) did not note the similarity of their new genus *Heteraria* to the Lower Carboniferous genera *Eomartiniopsis* Sokolskaya, 1941, or *Merospirifer* Reed, 1949. In the case of the former this was undoubtedly because of their misunderstanding of the dorsal interior of the type species of *Eomartiniopsis*, which was described by Sokolskaya as having short or incipient "septal" plates. In fact, there are no dorsal plates supporting the cardinalia in *Eomartiniopsis*. Thus, the dorsal interiors of *Eomartiniopsis*, *Merospirifer*, and *Heteraria* are similar. *Merospirifer* Reed, 1949, was recently redescribed by Brunton (1984) and appears to be similar to *Eomartiniopsis* in the dorsal interior. As far as we can determine, these genera can be internally differentiated only by the presence of unusually wide, transverse, flattened dental ridges in the ventral valve of *Heteraria* with narrow, more conventional ridges in *Eomartiniopsis* and *Merospirifer*.

There are only three Late Carboniferous eomartiniopsinine species known, *Eomartiniopsis planosinuata* Poletaev, 1975, from the early Bashkirian of the Donets Basin, *E.*? *susanae* Martinez-Chacon, 1978, from the middle to late Bash-

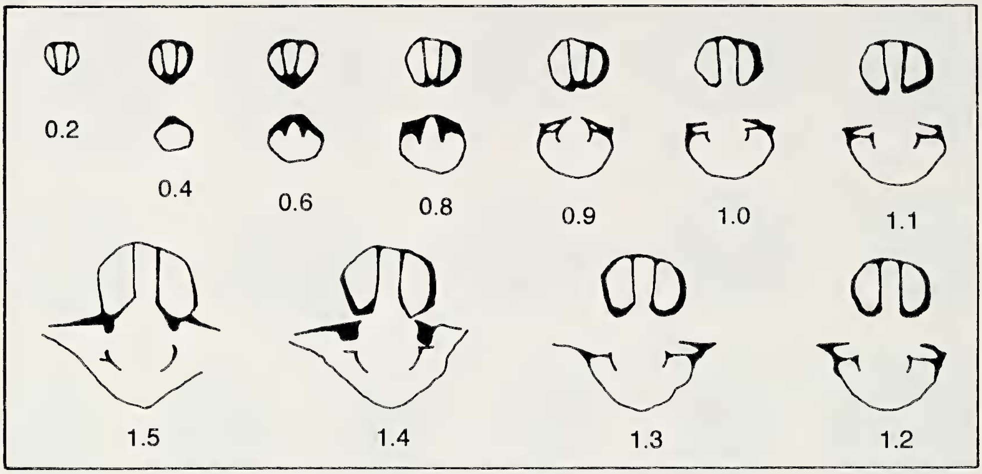


Fig. 22.—Transverse serial sections of ?*Heteraria canadiensis* n. sp., paratype, GSC 115643, from GSC locality 56430, × 3. Numbers refer to distance in millimeters from ventral beak.

kirian of the Cantabrian Mountains, northern Spain, and the new species described below from the upper Bashkirian or lower Moscovian of Ellesmere Island. Their similarities and differences are discussed below.

?*Heteraria canadiensis*, new species
(Fig. 21.17–21.32, 22)

Holotype.—GSC 115640, Figures 21.18–21.22, from GSC locality 56430.

Paratypes.—GSC 115641, Figures 21.23–21.27, from GSC locality C-5202; GSC 115642, Figures 21.28–21.32, from GSC locality 56430; GSC 115639, Figure 21.17, micro-ornament, from GSC locality 56430A; Figure 22, GSC 115643.

Description.—Small to medium size for genus, smooth, thin shelled; transversely subovate or subpentagonal in outline; subequally biconvex, both valves considerably inflated; beaks small; hingeline narrow, half of maximum width; maximum width attained near midlength or slightly posterior to midlength; cardinal extremities rounded in all growth stages, but slightly angular in juveniles and delineated by obscure reflexing of outer surface of ventral valve; ornament consisting of irregularly spaced growth varices and some adult specimens have faint low costae or plicae on flanks; micro-ornament consisting of very small pits.

Ventral valve most convex in umbonal region; beak small and slightly incurved; sulcus originating as shallow groove posteriorly in umbonal region, becoming broader and deeper anteriorly, with angular borders and flattened floor; front margin strongly uniplicate with angular tongue; flanks gently convex or nearly flat; interarea moderately high, sharply defined, triangular; dental ridges (sensu Dunlop, 1962) very wide, flattened; deltidial or stegidial plates not observed; interior with short, slender, subparallel intrasinal dental adminicula.

Dorsal valve similar in convexity to ventral valve and almost as long; prominent umbo has small beak; fold poorly defined posteriorly, forming only low, rounded ridge, becoming well expressed only anteriorly; flanks slightly concave near the ears and gently convex otherwise; dorsal interarea low, acutely triangular, inconspicuous; interior with small ctenophoridium and narrow, vertical, medially concave crural bases which become broader and convergent anteriorly; other details not preserved in sectioned specimen.

Measurements.—See Table 18.

Diagnosis.—This species is characterized by its transversely subovate to subquadrate outline, almost equal thickness of the ventral and dorsal valves, small

Table 18.—*Measurements (in millimeters) of* Heteraria canadiensis, *n. sp.*

GSC number	Length	Width	Thickness	Hingeline
115640	>17.0	~21.0	14.5	~10.5
115641	13.6	16.2	9.4	~7.5
115642	11.1	12.3	8.1	6.2

ventral umbo with a short, narrow beak, deep flat-bottomed sulcus with anteriorly abrupt slopes, and very wide, flattened dental ridges.

Comments.—*Heteraria canadiensis* n. sp. resembles *Eomartiniopsis planosinuata* Poletaev, 1975, from the Lower Bashkirian of the Donets Basin. The Ukrainian species differs in its smaller size, very unequal convexity of ventral and dorsal valves, comparatively longer ventral umbo, higher interarea, and shallower sulcus than the Canadian species.

Eomartiniopsis susanae Martinez-Chacon, 1978, from the San Emiliano Formation (Bashkirian) of northern Spain, differs from *H. canadiensis* in having a roundly subquadrate outline with its greatest width at midlength or anterior to it, and a narrower sulcus with distinct grooves on the midline.

Distribution.—GSC locality 56430, four complete shells, two ventral valves, and one dorsal valve. GSC locality C-5202, two complete shells. GSC locality C-4085, one ventral valve. GSC locality 56430A, a well-preserved large ventral valve.

Indeterminate martinioid
(Fig. 23.5–23.9)

Description.—Small, strongly and unequally biconvex with much thicker dorsal valve; outline subelliptical to rounded subpentagonal; lateral profile subelliptical, almost subovate; anterior profile thickly lenticular; sulcus well developed but fold scarcely discernible; anterior commissure strongly uniplicate; surfaces smooth except for very faint, widely spaced radial lirae and fine growth lines, the former possibly reflecting internal vascular markings.

Ventral valve shorter and much thinner than dorsal valve; umbonal region moderately convex, defined by strongly concave lateral flexures, forming compressed posterolateral margins; beak very small, incurved; delthyrium open, small, triangular; interarea small, narrow, procline, triangular, weakly delineated by scarcely perceptible beak ridges; lateral slopes gently concave, sloping evenly to lateral margins; sulcus originating in umbonal region, becoming smoothly rounded and moderately deep and wide anteriorly; interior unknown.

Dorsal valve very thick, strongly inflated, with moderately swollen umbonal region delineated by concave flexures that are less concave than those of opposite valve; dorsum strongly convex, lateral slopes more gently convex, sloping evenly to lateral margins; fold confined to very slight dorsal deflection of shell surface near anterior margin; interarea very short and narrow, about orthocline; interior unknown.

Comments.—We little doubt that this shell represents an adult individual because of the well-developed sulcus and rotund shape. The translucent shell material provides no suggestion of internal structures in either valve. Growth form, lack of ornamentation, and probable lack of internal plates indicate that this small shell is undoubtedly a martinioid of some kind. However, the short ventral valve with procline ventral interarea, greatly swollen dorsal valve, and unusual microornament preclude assignment to a known species, genus, or even family.

Distribution.—GSC locality 56430 (one specimen).

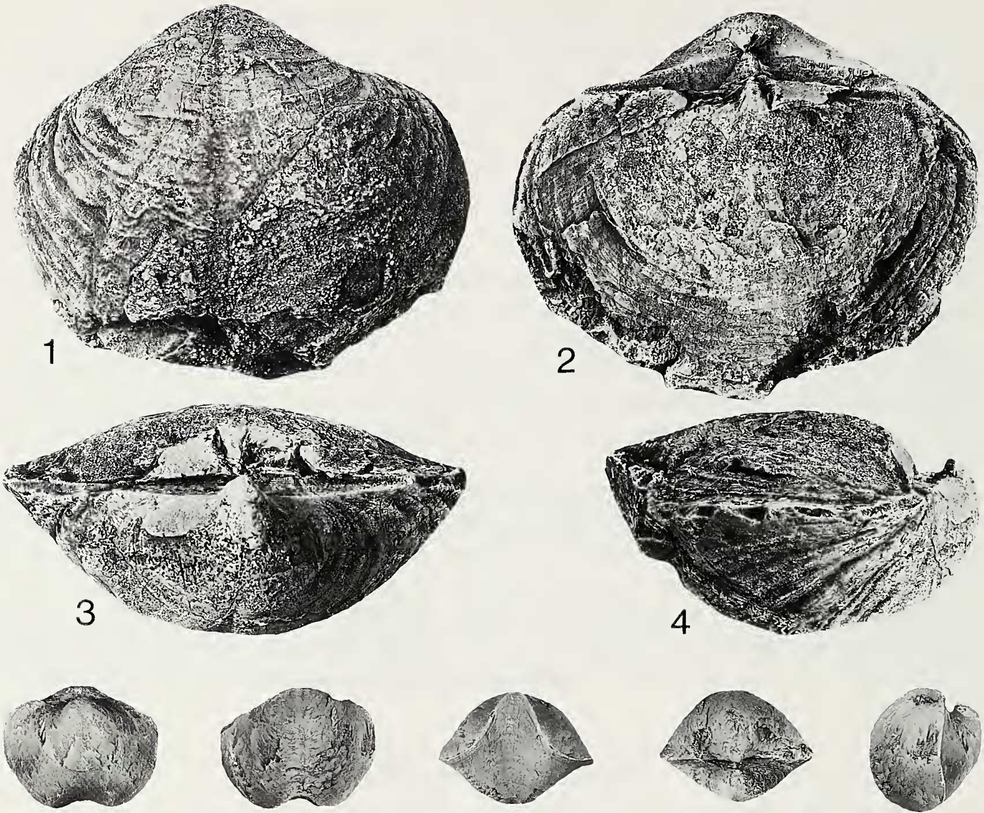


Fig. 23.—Martinioids. 23.1–23.4, ?*Jilinmartinia* cf. *J. sokolovi* (Chernyshev, 1902), ventral, dorsal, posterior, and lateral views, GSC 115644, × 1. 23.5–23.9, indeterminate martinioid, ventral, dorsal, anterior, posterior, and lateral views, GSC 115645, × 2.

Superfamily Spiriferoidea King, 1846
Family Spiriferidae King, 1846
Subfamily Sergospiriferinae Carter, 1994
Genus *Anthracospirifer* Lane, 1963
Anthracospirifer cf. *A. occiduus* Sadlick, 1960

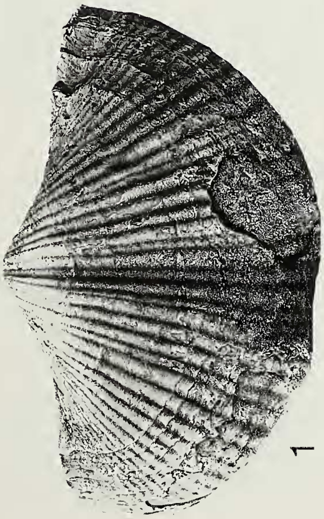
(Fig. 24.9–24.13)

1960 *Spirifer occiduus* Sadlick, p. 1210.

Description.—This description is based on two specimens from GSC locality 56430. An almost complete shell with incomplete cardinal extremities measures approximately 37 to 38 mm in width, 22.7 mm in length, and 15.8 mm in thickness. The remaining specimen is a small ventral valve.

→

Fig. 24.—Spiriferoids. 24.1–24.8, *Elinoria ellesmerensis* n. sp.; 24.1–24.3, ventral, anterior, and posterior views of a large ventral valve, GSC 115646; 24.4–24.8, ventral, dorsal, anterior, posterior, and lateral views of the holotype, GSC 115647, × 1. 24.9–24.13, *Anthracospirifer* cf. *A. occiduus* Sadlick, 1960, anterior, lateral, ventral, dorsal, and posterior views, GSC 115648, × 1; 24.14–24.16, ?*Brachythyrina* sp., ventral, anterior, and posterior views of a ventral valve, GSC 115649, × 1.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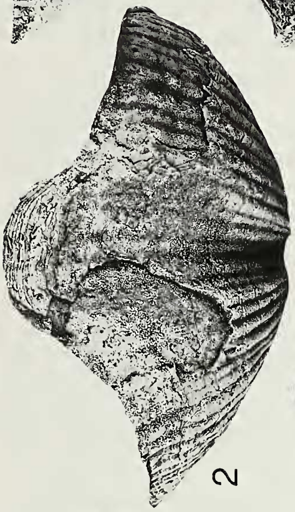
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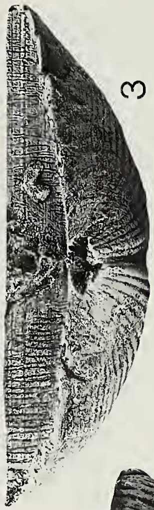
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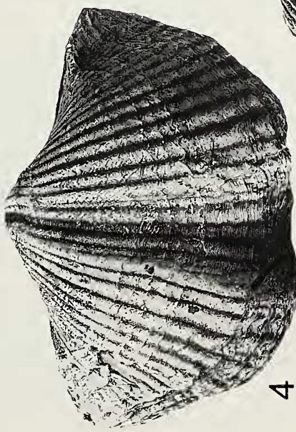
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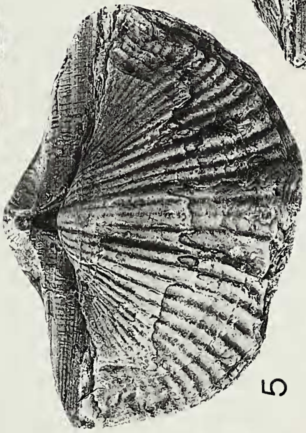
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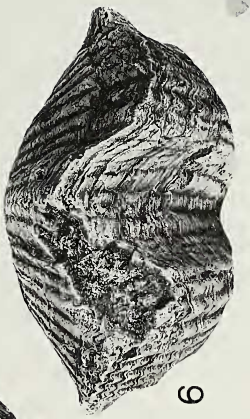
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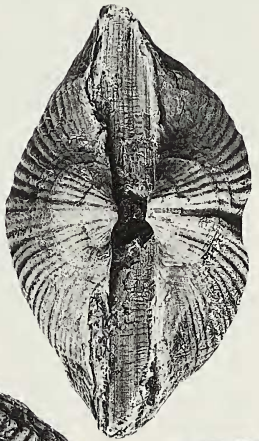
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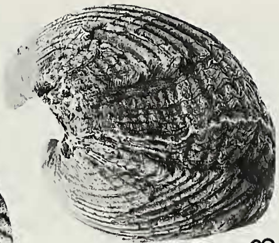
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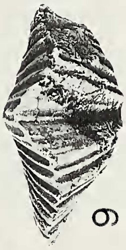
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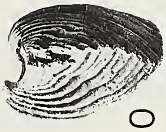
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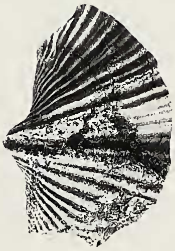
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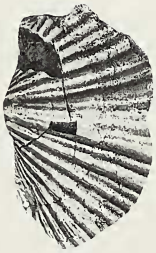
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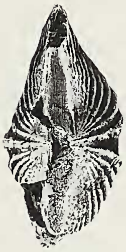
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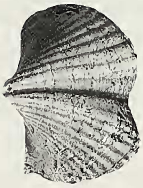
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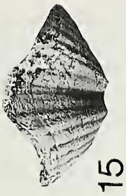
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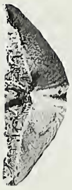
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Ventral valve with short, narrow ventral umbo, moderately high, triangular interarea, deep V-shaped sulcus with obvious median rib and three ribs on each side of sulcus, up to 14 or 15 ribs on each flank, four or five of them bifurcated.

Dorsal valve with short, strongly incurved umbo, narrow acute interarea, prominent fold with groove on midline, and four or five bifurcated ribs on each flank.

Remarks.—This shell is similar in general shape and ribbing to the lectotype of *Anthracospirifer occiduus* (Sadlick), as illustrated by Girty (1927) and Gordon (1975). The shell from Ellesmere Island differs from the lectotype in having a higher ventral interarea and concave lateral slopes on the ventral valve and gently convex flanks on the dorsal valve.

Family Choristitidae Waterhouse, 1968
Subfamily Angiospiriferinae Legrand-Blain, 1985
Genus *Elinoria* Cooper and Muir-Wood, 1951
Elinoria ellesmerensis, **new species**
(Fig. 24.1–24.8)

Holotype.—GSC 115647, Figures 24.4–24.8, from GSC locality 56430.

Paratypes.—GSC 115646, Figures 24.1–24.3, a large ventral valve from GSC locality 60194.

Description.—Medium to large, subequally biconvex; outline transversely subovate to subsemicircular in early growth stages, becoming subtrapezoidal in adults; cardinal extremities alate to submucronate; sulcus moderately wide and deep, well defined; fold low, rounded, sharply delineated; anterior commissure uniplicate; flanks with few, simple, low, rounded costae, separated by narrow interspaces, and strong, irregularly spaced growth varices; width of costae varies from 0.6 to 0.8 mm near umbo, up to 3.0 mm or more near anterior margin; micro-ornament consisting of fine concentric growth lines and capillae; shell substance of moderate thickness for genus, reaching 3.0 mm thick in ventral umbo.

Ventral valve moderately to strongly inflated with greatest convexity near or posterior to midvalve; surface of valve regularly convex except for sulcus and slight flexure near ears; umbo comparatively short and umbonal angle usually about 110 degrees; interarea flat or slightly concave and of moderate height, vertically grooved, abruptly truncated laterally, apsacline to nearly catacline; delthyrium forming equilateral triangle, or slightly higher than wide, open; sulcus subtending angle of about 30 degrees; sulcus with strong median costa, one pair of strong lateral sulcal costae which also originate at beak, and two or three pairs of weak, flat costae bifurcating from sulcus-bounding costae; sulcus spreading anteriorly in some large specimens to incorporate one or two pairs of costae from lateral slopes; lateral slopes with about 15 simple, rounded costae at anterior margin of each flank in adult specimens.

Ventral interior lacking dental plates, bearing deep, narrow, depressed musclescar with short partial myophragm.

Dorsal valve less inflated than opposite valve, forming semicircular anterior profile; dorsal umbo blunt, beak small, incurved; interarea orthocline, low, with acute extremities; fold low and clearly delineated, usually bearing four costae, flatter than those of lateral slopes; lateral costae simple, excluding those nearest fold; dorsal interior unknown.

Measurements.—See Table 19.

Diagnosis.—The large size, transversely subtrapezoidal outline, clearly defined sulcus, coarse simple costae, and absence of dental plates distinguish this species from other Hare Fiord spiriferids.

Comparisons.—*Elinoria ellesmerensis* n. sp. is most similar to *E. rectangula* (Kutorga) sensu Chernyshev (1902), from the Lower Permian (Asselian) of the

Table 19.—*Measurements (in millimeters) of* Elinoria ellesmerensis, *n. sp.*

GSC number	Length	Width	Thickness	Hingeline
115646	45.7	69.2	20.5	64.1
115647	41.3	57.0	34.1	55.3

western slope of the middle Urals. The Canadian species differs from the Russian one in its thicker, more stout shell, narrower width, a higher interarea in adults, mucronate cardinal extremities in juveniles, and simple or very rarely bifurcating lateral costae. Two other similar Russian species are *Elinoria kremenskensis* (Semikhatova, 1953) from the Upper Moscovian and Kasimovian of the Don-Medveditsa district, and *E. subgrandis* Poletaev, 1986, from the lower Gjelian of the Donets Basin and Samarskaya Luka on the middle Volga River. *Elinoria kremenskensis* is much smaller, almost half the size, lacks mucronate cardinal extremities, has a poorly delineated sulcus, and often has bifurcated costae on the lateral slopes. *Elinoria subgrandis* differs in its less inflated profile, semicircular to subquadrate outline, and has bifurcating costae on the lateral slopes.

Distribution.—GSC locality 56430 (four specimens, two complete, including the holotype); GSC locality C-4083 (three more or less complete small ventral valves); GSC locality 60194 (one large ventral valve paratype and one small complete shell). A similar or identical species occurs in the Ladrones Limestone of southeastern Alaska.

Genus *Brachythyrina* Frederiks, 1929
?*Brachythyrina* sp.
(Fig. 24.14–24.16)

Description.—This description is based on a single ventral valve from GSC locality C-4087.

Medium size for genus (length 19.8 mm, width 24.4 mm, thickness 10.7 mm), moderately inflated, most convex in umbonal region; outline transversely subtrapezoidal; anterior commissure uniplicate; greatest width at hingeline; lateral extremities subangular, slightly mucronate and compressed in adult and transversely subovate in juveniles; beak small, narrow, incurved; beak ridges inconspicuous on umbo, angular and well defined near ears; interarea acutely triangular, weakly to moderately concave, of moderate height, catacline, vertically grooved; hingeline denticulate; delthyrium slightly higher than wide, apparently open; sulcus strong, well defined, moderately wide and deep, rounded; median sulcal costa very weak, originating in umbonal region; two pairs of lateral sulcal costae originating by bifurcating from sulcus-bounding costae, remaining simple for entire length; macro-ornament consisting of eight to ten simple, low, flattened, rounded costae on each flank and rare irregular growth varices; micro-ornament consisting of fine, regularly spaced growth lines; capillae not observed; umbonal region thickened with callus; inner structures not observed.

Comments.—This specimen was assigned to *Brachythyrina* because it has the external characters of that genus and because it is externally similar to the Middle–Upper Bashkirian species *Spirifer* (*Brachythyrina*) *probus* Rotai, 1951, from the Donets Basin and *Brachythyrina pinica* Martinez-Chacon, 1978, from the Cantabrian Mountains, northern Spain.

Subfamily Choristitinae Waterhouse, 1968
Genus *Parachoristites* Barchatova, 1970
Parachoristites tellevakensis, **new species**
(Fig. 25.1–25.15)

Holotype.—A nearly complete shell with incomplete cardinal extremities, GSC 115650, Figures 25.1–25.5, collected by Bonham-Carter at GSC locality 60194.

Paratypes.—Two almost complete shells, GSC 115651 and 115652, Figures 25.6–25.15, from the same locality as the holotype.

Description.—Medium to large; outline subtriangular, transversely subrhomboidal, or subsemicircular; hingeline equal to or only slightly shorter than greatest width in shells with moderately large and incurved ventral beak; greatest thickness located near midlength; ventral valve slightly thicker than dorsal; ventral interarea high or moderately high for genus, with distinct vertical grooves and truncated lateral extremities; sulcus weakly developed, shallow, narrow, poorly defined; anterior com-

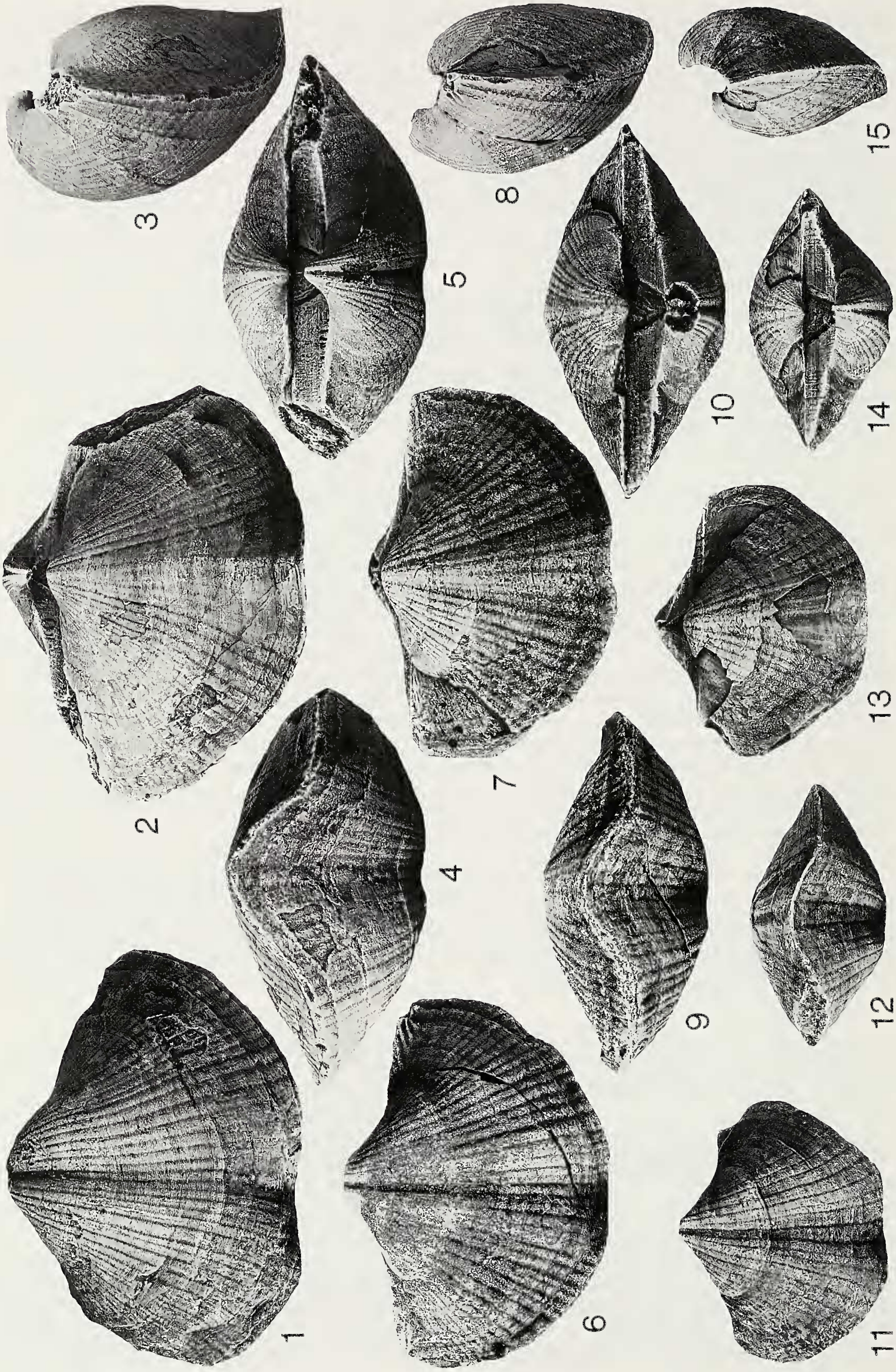
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Table 20.—*Measurements (in millimeters) of the types of* Parachoristites tellevakensis, *n. sp. from GSC locality 60194.*

GSC number	Length	Width	Thickness	Hingeline
115650	47.4	~70.0	31.8	—
115651	>40.3	54.5	27.1	51.6
115652	31.8	39.5	21.3	~34.8

missure usually clearly uniplicate; fold very low and rounded posteriorly but clearly defined and elevated anteriorly; macro-ornament consisting of numerous flattened, rounded costae, mostly irregularly bifurcated or trifurcated, with 11 to 13 costae in anterior part of sulcus, including very weak median rib, and up to 20 costae on each lateral slope; costae separated by narrow interspaces and sometimes crossed by strong, irregularly spaced growth varices; micro-ornament consisting of fine capillae and fine regular growth lines.

Ventral valve most convex in umbonal region; beak of small to moderate size, incurved, overhanging hingeline; umbonal region moderately broad with umbonal angle of about 95 to 100 degrees; flanks gently convex; lateral extremities slightly compressed on ears, forming sharp beak ridges; sulcus originating at beak, flat and shallow, becoming wider and deeper anteriorly, producing moderate tongue; interarea apsacline, clearly triangular, concave in juveniles, becoming flat with nearly parallel sides at maturity, and abruptly truncated extremities; delthyrium open, triangular, higher than wide, deltidial plates not observed; interior with thick, weakly diverging, moderately long dental adminicula which reach almost one-quarter length of valve; delthyrial plates conjoin in beak, becoming free anteriorly and including between them muscle impressions; posterior inner surface of the valve with traces of bifurcating vascular impressions.

Dorsal valve usually semicircular in outline, moderately convex with short incurved umbo and low subparallel interarea; fold low, medially flattened, rounded, clearly defined, with shallow midline groove and six to ten obscure costae at anterior margin; lateral slopes with 18 to 20 ribs on each side, most of which bifurcate; interior with ctenophoridium composed of numerous plates.

Measurements.—See Table 20.

Diagnosis.—This species is distinguished by its large size, comparatively high ventral interarea with sharp beak ridges in young stages; weak shallow sulcus with obscure borders; low, rounded, clearly defined fold; low, flat, irregularly bifurcating costae, and moderately long, thick, subparallel dental adminicula.

Comments.—*Parachoristites tellevakensis* n. sp. bears similarity to the type species, *P. volongaensis* Barkhatova, 1970, from the Bashkirian of the Volonga River and north Timan (Russia). The Canadian species differs in usually being smaller with a longer more subrhomboidal outline, a higher subtriangular ventral interarea, more elevated fold anteriorly, and flatter costae.

Parachoristites tellevakensis n. sp. has some similarity to two other species of large spiriferids from the Televak Limestone Member. The species we refer to here as ?*Trautscholdia* sp., from GSC locality C-56430, differs in its transversely subovate outline, absence of mucronate cardinal extremities, low subparallel ventral interarea, very weak sulcus with medial groove, very weak tongue, almost flat dorsal valve, and a fold defined only by deep interspaces.

Elinoria ellesmerensis n. sp. differs in having a high subparallel ventral interarea; a strong, clearly restricted sulcus; simple coarse costae; and no dental adminicula.

←

Fig. 25.—Spiriferoids. 25.1–25.15, *Parachoristites tellevakensis* n. sp., ventral, dorsal, lateral, anterior, and posterior views of three specimens, including the holotype (25.1–25.5), GSC 115650–115652, respectively, × 1.

Distribution.—This species is moderately common at GSC locality 60194 (27 complete specimens) and GSC locality 56430 (more than 12 complete specimens, plus disarticulated valves).

Genus *Trautscholdia* Ustritsky, 1967
?*Trautscholdia* sp.
(Fig. 26.2–26.6)

Description.—This description is based on a single large specimen (length 48.4 mm, width 66.2 mm, thickness 29.5 mm), from GSC locality 56430.

Large, ventribiconvex, transversely subovate in outline with moderately thick ventral and weakly convex dorsal valves; cardinal extremities rounded on all growth stages; maximum width attained near midlength; ventral interarea low, acutely triangular, apsacline, concave; hingeline slightly shorter than greatest width, denticulate; sulcus very weak, narrow, poorly defined, medially grooved; lateral slopes with up to 30 wide, low, flattened, rounded costae at anterior margin, mostly simple or irregularly bifurcating or, rarely, trifurcating; growth varices irregularly spaced; micro-ornament consisting of strong capillae, about eight to ten per mm, and very fine, regularly spaced growth lines forming cancellate pattern; both valves much thickened posteriorly; ventral interior with nearly parallel dental adminicula.

Comments.—This specimen is similar to *Choristites jigulensis* (Stuckenberg, 1905) sensu Ivanov and Ivanova, 1937 (pl. 11, fig. 1 and pl. 12, fig. 1) from the Upper Moscovian (Podolsky Horizon) of Shchurovo village, Moscow Basin. However, the Upper Moscovian specimens and the specimen from Ellesmere Island differ from the lectotype in the outline of their shells. The lectotype of *Spirifer jigulensis* Stuckenberg, 1905, is from the Lower Gjelian of the Samarskaya Luka (Volga River near the city of Samara). This lectotype has a subquadrate, not a transversely subovate, outline; a shorter hingeline; and a longer ventral umbo than either the Russian Upper Moscovian specimens or the specimen from Ellesmere Island.

Trautscholdia jigulensis (Stuckenberg, 1905), in the junior author's opinion, has many synonyms, including other species described by Stuckenberg from the type locality at Samarskaya Luka. We do not include Upper Moscovian specimens in the synonomy of *T. jigulensis* (Stuckenberg). It is possible that the specimens of Moscovian age represent a cognate but different, perhaps undescribed, species.

Subfamily Tangshanellinae Carter, 1994
Genus *Tangshanella* Chao, 1929
?*Tangshanella* sp.
(Fig. 26.7–26.9)

Description.—This description is based on a single incomplete specimen from GSC locality 56430.

Medium size (length 38.3 mm, width 44.4 mm, thickness 23.5 mm), moderately inflated, ventribiconvex; outline transversely subovate in all growth stages; ventral umbo narrow, moderately inflated, and extended; cardinal extremities and lateral margins well rounded, hingeline very narrow (15.2 mm), about one-third maximum width; sulcus shallow, poorly defined, with weak groove in midline; fold low, poorly delineated, expressed only anteriorly, producing uniplicate anterior commissure; costae wide, low, roundly flattened, mostly bifurcating but almost disappearing at posterolateral margins; growth varices coarse, rare, irregular; micro-ornament not observed.

Ventral valve twice as thick as dorsal valve, moderately and regularly convex with maximum width at midlength; interarea apsacline, moderately high, triangular; delthyrium open, wider than sides of interarea; hingeline very narrow, denticulation not observed; sulcus with three pairs of primary costae, weak median costa, which begins much later than primary costae; all primary costae usually bifurcate anteriorly; dental adminicula either very short or absent (beak lost).

Dorsal valve subovate, very gently convex, with small, prominent umbo, low, almost linear, dorsal interarea, and wide notothyrium; interior not observed.

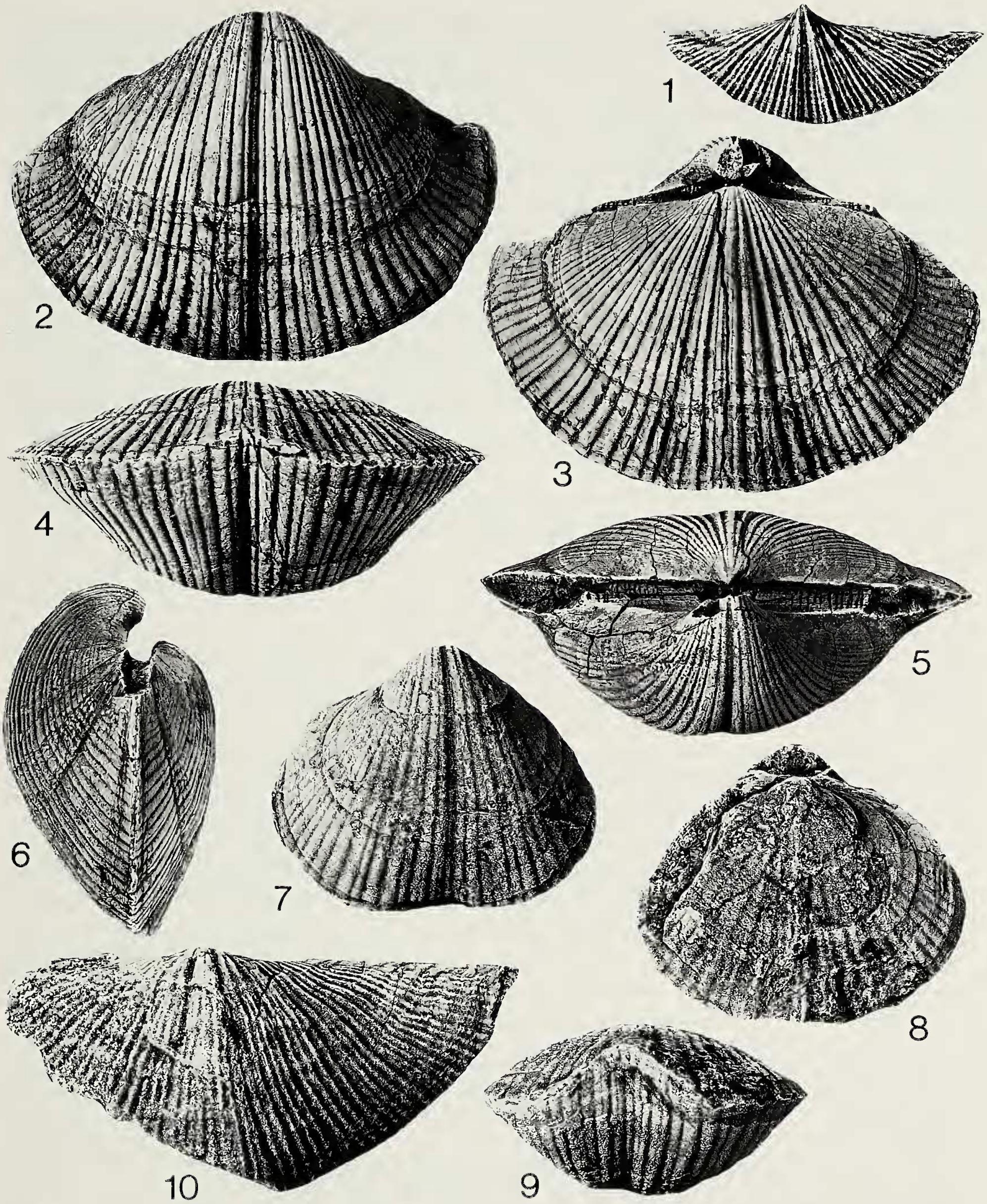


Fig. 26.—Spiriferoids. 26.1, 26.10, *Gypospirifer* sp.; 26.1, a small ventral valve, GSC 115653; 26.10, a large dorsal valve, GSC 115656. 26.2–26.6, ?*Trautscholdia* sp., ventral, dorsal, anterior, posterior, and lateral views, GSC 115654. 26.7–26.9, ?*Tangshanella* sp., ventral, dorsal, and anterior views, GSC 115655. All × 1.

Diagnosis.—The transversely subovate outline, extremely narrow hingeline, wide, roundly flattened commonly bifurcating costae, shallow, poorly delimited sulcus and weak fold, and possible lack of dental adminicula serve to differentiate this species from all other spiriferids in the Televak Limestone Member.

Comments.—This Canadian specimen differs from the other representatives of the genus *Tangshanella* Chao, 1929. The type species, *T. kaipingensis* Chao, from the Tangshan Limestone of the Penchi Series (Upper Carboniferous) of north China, differs in having a thicker shell with a much stronger sulcus and fold, a wider hingeline, and a higher ventral interarea. *Tangshanella taimyrica* (Einor, 1939), from the Makarovsky Horizon (Bashkirian) of Taimyr, and *T. byrangi* Cherniak, 1963 (in Ustritskii and Cherniak, 1963), from the Kholodninskaya Suite (Bashkirian) of Taimyr, have wider ventral interareas, and clearly fasciculate, strong, thin costae. They may not belong in this genus.

This ?*Tangshanella* sp. from the lower Hare Fiord Formation is similar in outline, growth form, ribbing, and foldsulcus to *Neomunella* Ozaki, 1931, from the Pen-hsi-hsien (Upper Carboniferous) of Manchuria (north China). However, the latter has short, distinct, divergent dental plates. We assign our specimen to the genus *Tangshanella* with a query (?) because we cannot determine whether or not there were short dental adminicula in this incomplete specimen.

Family Trigonotretidae Schuchert, 1893
Subfamily Neospiriferinae Waterhouse, 1968
Genus *Gypospirifer* Cooper and Grant, 1976
Gypospirifer sp.
(Fig. 26.1, 26.10)

Description.—This description is based on two specimens. A small ventral valve, perhaps a juvenile, and a large dorsal valve were collected at GSC locality 56430.

Ventral valve moderately convex, strongly transverse with maximum width at hingeline; cardinal extremities slightly mucronate, slender (length 15.2 mm, width 43.3+ mm, complete width probably close to 50.0 mm, thickness ~8.0 mm); commissure uniplicate; beak short, incurved, not swollen; sulcus shallow, well delineated by bounding costae and producing angle near 25 degrees; interarea triangular, comparatively high (approximately one-third valve length), slightly concave, strongly vertically grooved; delthyrium as high as wide, open or partly closed by stegidial plates; costae fine, bifurcated or trifurcated only in umbonal region, anteriorly simple, numbering ten per cm near anterior commissure; sulcus with median costa originating at beak; two pairs of costae, split from bounding costae inside sulcus, one pair split outside; growth lamellae distinct, regularly spaced, slightly raised to give tegulate appearance.

Dorsal valve of average size (length 33.4 mm, width >67.2 mm, probably about 85 to 90 mm when complete); outline transversely semicircular with maximum width at hingeline; dorsum moderately convex; maximum thickness in umbonal region; flanks weakly convex with slightly compressed ears; cardinal extremities acute and mucronate in all growth stages; fold gently rounded, not raised much above flanks; costae medium size (eight per cm near anterior commissure), rounded, separated by rounded interspaces, 26 to 28 on flanks, mostly trifurcating from five to six primary ribs on umbo; ten costae on fold, bifurcating from median rib; growth varices numerous, regular; interior and microornament not observed.

Superfamily Paeckelmanelloidea Ivanova, 1972
Family Strophopleuridae Carter, 1974
Subfamily Strophopleurinae Carter, 1974
Genus *Cantabriella* Martinez-Chacon and Rio Garcia, 1987

This genus was assigned originally to the Licharewiidae by Martinez-Chacon and Rio Garcia (1987). However, the type species, *Orulgania schulzi* Martinez-Chacon, 1978, is impunctate according to Martinez-Chacon (1978). The pits described later by Martinez-Chacon and Rio Garcia (1987:pl. 1) appear to be an artifact of chemical corrosion. The type species of *Cantabriella* clearly has affinities with the paeckelmanellids, having such characters as disproportionately strong sulcus-bounding ribs, high ventral interarea, noncostate foldsulcus, strongly denticulate hingeline, close-set, intrasinal dental adminicula, and capillate micro-ornament.

The authors of this genus included three species, all the from the Upper Carboniferous of Spain: *Cantabriella schulzi* (Martinez-Chacon, 1978) from Upper Bashkirian of Leon and Asturias; *C. palentina* (Martinez-Chacon, 1978) from Upper Moscovian of Palencia, and *C. lavianica* Martinez-Chacon, 1987, from Lower Moscovian of Asturias. In our opinion *Spirifer* (*Syringothyris*?) *bistritzae* Schellwien, 1900, from the Trogkofel shales (?Lower Permian) of the Carnic Alps of northern Slavonia also can to be assigned to this genus.

Cantabriella sp. A
(Fig. 27.6–27.10)

Description.—This description is based on a single, nearly complete, possibly slightly deformed shell collected at GSC locality 56430.

Medium size (length 13.6 mm, width >20.0 mm, thickness 11.1 mm), subequally biconvex, transversely subpentagonal in outline; lateral extremities acute and angular in all growth stages, becoming almost rectangular in adults; maximum width attained at hingeline; sulcus well developed and defined; anterior commissure uniplicate; ornament consisting of seven to eight simple, rounded, flattened costae on flanks; sulcus and fold smooth with weak, shallow furrow on midline; micro-ornament consisting of weak, irregularly spaced growth varices, very faint regularly and closely spaced growth lines, crossed by comparatively coarse capillae.

Ventral valve subpyramidal with maximum thickness in umbo; beak small, acute, incurved; ventral interarea high, procline, concave only near beak, weakly defined by rounded beak ridges, grooved by strong vertical furrows; delthyrium moderately broad but higher than wide; deltidial plates not observed; sulcus originating at beak as narrow groove bordered by pair of wide costae, becoming wider and deeper anteriorly, producing flattened, long tongue in anterior third of valve; interior with dental adminicula.

Dorsal valve transversely semicircular to subelliptical in outline, most convex in umbonal region, nearly as thick as ventral valve, reaching maximum thickness near midlength; umbo slightly swollen; beak small, inconspicuous; fold defined only by bounding interspaces posteriorly, becoming slightly raised anteriorly from midlength; internal details not observed.

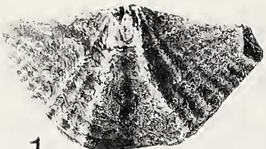
Diagnosis.—The subpentagonal outline, almost equal thickness of the subpyramidal ventral and swollen dorsal valves, procline ventral interarea, and simple costae rapidly decreasing to size toward the ears are the most characteristic features of this specimen.

Cantabriella sp. B
(Fig. 27.1–27.5)

Description.—This description is based on a single, almost complete shell with broken cardinal extremities, spalled surface, but well-preserved growth form, from GSC locality C-4085.

Medium size (length 15.7 mm, width >23.0 mm, thickness 10.6 mm); very unequally ventribiconvex; transversely subtriangular in outline; lateral extremities angular in all growth stages; maximum width attained at hingeline; sulcus and fold well developed and defined; anterior commissure uniplicate; ornament consisting of from nine to 11 rounded, flattened costae on flanks, broad near foldsulcus, becoming much finer laterally; bounding costae bifurcate on one side only; fold and sulcus smooth; sulcus with subangular floor; micro-ornament not preserved but consisting at least of more or less regularly spaced growth varices.

Ventral valve subpyramidal, much thicker than dorsal valve, with maximum thickness in umbonal region; flanks concave, sloping evenly to anterolateral margins; ears compressed; umbonal region narrowly elongated; beak small, acute, slightly incurved; ventral interarea high, catacline or nearly procline, generally flat, weakly concave near beak, defined by sharp beak ridges; surface of interarea with strong vertical grooves; delthyrium narrow, almost three times higher than wide; subdelthyrial plate long, set well below surface of interarea between close-set intrasinal dental adminicula; stegidial plates not observed; sulcus comparatively shallow, originating as narrow groove, becoming wider and deeper anteriorly, defined by strong bounding costae.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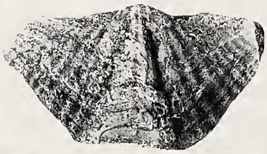
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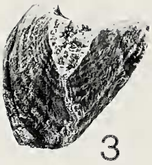
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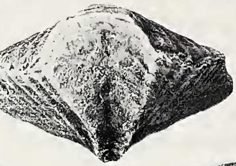
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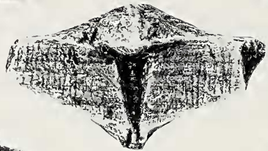
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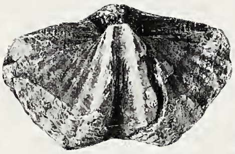
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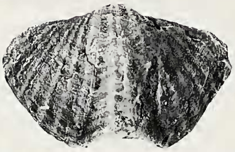
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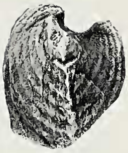
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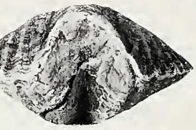
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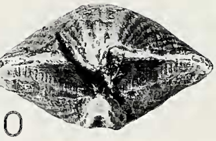
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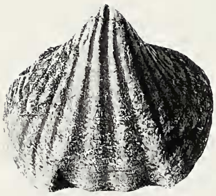
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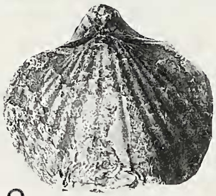
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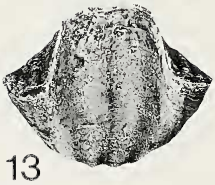
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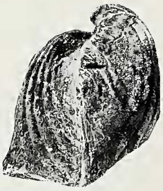
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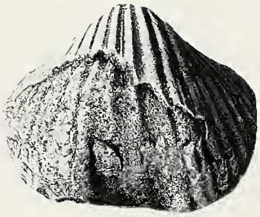
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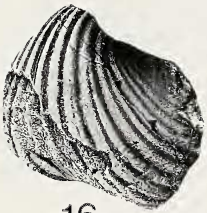
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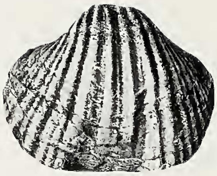
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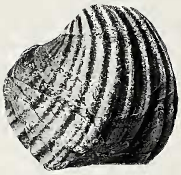
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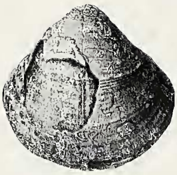
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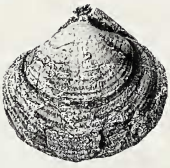
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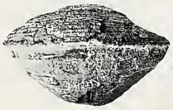
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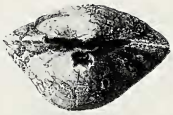
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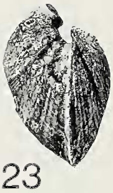
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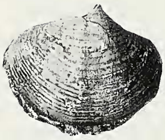
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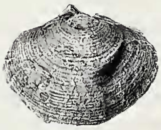
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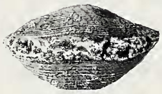
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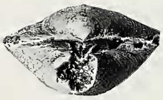
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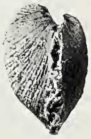
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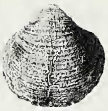
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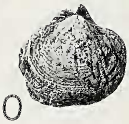
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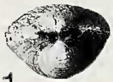
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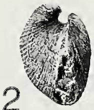
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Dorsal valve transversely trapezoidal in outline, with maximum thickness at midlength, much thinner than opposite valve; umbo slightly produced above beak ridges; middle part of valve slightly convex or swollen from beak to front commissure; flanks concave, ears compressed; fold originating at small beak, well defined by bounding interspaces, slightly flattened medially near anterior margin; internal details not observed.

Diagnosis.—This specimen probably also represents a new species of this genus, differing from other species of *Cantabriella* in having a transversely triangular outline, concave flanks, elongated and compressed ears, and nine to 11 ribs on each flank.

Superfamily Brachythyridoidea Frederiks, 1924
Family Brachythrididae Frederiks, 1924
Genus *Meristorygma* Carter, 1974
Meristorygma arctica Carter, 1974
(Fig. 27.11–27.14)

v*1974 *Meristorygma arctica* Carter, p. 690, pl. 3, fig. 21–30; text-fig. 4.

Original Diagnosis.—"This species is characterized by its transversely ovate outline, compressed lateral extremities, two or four sulcal costae, and dorsally deflected fold at the anterior margin."

Comments.—This species was originally described on the basis of eight specimens from GSC locality 56430. Our present collection contains nearly 100 specimens, many complete, from the same locality.

Some natural molds of the ventral valves show that the type species of *Meristorygma* has a ramose, radially arranged vascular system surrounding the muscle field with a pair of strong vascula media, which approximately correspond to the strongest pair of costae in the sulcus. The distinctive vascular system in this genus constitutes an important difference between it and *Brachythyris*, because the latter has a weak, simple, radial, *Martinia*-like vascular system.

Distribution.—In addition to the large collection from GSC locality 56430 there is one incomplete specimen from GSC locality C-4087 and four specimens from GSC locality 56430A. A similar species occurs in the Ladrones Limestone of southeastern Alaska.

Meristorygma, **new species A**
(Fig. 27.15–27.18)

Two disarticulated ventral valves of *Meristorygma* sp. from GSC locality 56430A preserve the general shape and most other characters of *Meristorygma arctica* Carter, 1974, but differ distinctly from that species in having four to five clearly expressed bifurcating costae on both flanks and a very thin, weak median

←

Fig. 27.—Paeckelmannelloids, brachythyridoids, and reticularioids. 27.1–27.5, *Cantabriella* sp. B, ventral, dorsal, lateral, anterior, and posterior views, GSC 115657, × 1.5. 27.6–27.10, *Cantabriella* sp. A, ventral, dorsal, lateral, anterior, and posterior views, GSC 115658, × 1.5. 27.11–27.14, *Meristorygma arctica* Carter, 1974, ventral, dorsal, anterior, and lateral views, GSC 115659, × 1. 27.15–27.18, *Meristorygma* n. sp. A, ventral and oblique views of two ventral valves, GSC 115660 and 115661, × 1. 27.19–27.32, *Phricodothyris asiatica* (Chao, 1929), ventral, dorsal, anterior, posterior, and lateral views of three specimens, GSC 115662–115664, respectively, × 1.

rib in the sulcus. Obviously these specimens represent a different, perhaps new, species but the lack of specimens prevents us from describing it.

Suborder Delthyridina Ivanova, 1972
Superfamily Reticularioidea Waagen, 1883
Family Elythidae Frederiks, 1924
Subfamily Phricodothyridinae Caster, 1939
Genus *Phricodothyris* George, 1932
Phricodothyris asiatica (Chao, 1929)
(Fig. 27.19–27.32)

1902 *Reticularia lineata* Martin: Chernyshev, p. 193, pl. 20, fig. 9–13.
1929 *Squamularia asiatica* Chao, p. 91, pl. 11, fig. 12–14.
1969 *Phricodothyris asiatica* (Chao): Pavlova, p. 95, pl. 8, fig. 4; pl. 9, fig. 1, 2, textfig. 10–11.
1990 *Phricodothyris asiatica*(Chao): Liang, p. 285, pl. 62, fig. 1–10; pl. 63, fig. 6–11; pl. 65, fig. 18; textfig. 38.

Description.—Average size for genus, moderately ventribiconvex, subcircular to suboval in outline, usually slightly wider than long, especially in early stages; cardinal extremities and lateral and front margins regularly rounded; anterior commissure straight; fold and sulcus absent or very weakly expressed; hingeline approximately half or less than half maximum width; concentric lamellae distinct but not prominent, numbering about seven to eight per five mm near or anterior to midlength.

Ventral valve moderately and evenly convex; beak rather broad, incurved, acute; interarea poorly defined, smooth; delthyrium large, equilaterally triangular, bounded on each side by low stegidial plates that form flanges nearly perpendicular to interarea surface; interior with moderately deep delthyrial ridges and deeply impressed pair of muscle scars.

Dorsal valve slightly less strongly convex than opposite valve; beak broad, blunt, extending into delthyrial opening and partly blocking it; interarea low, relatively narrow, bisected by wide notothyrium; interior not observed.

Measurements.—See Table 21.

Diagnosis.—This species is characterized by its slightly transversely suboval outline, short hingeline, narrow, distinct, concentric lamella, numbering seven or eight per five mm.

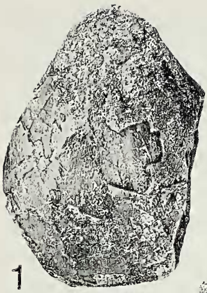
Distribution.—*Phricodothyris asiatica* (Chao, 1929) has been found at GSC locality 56430 (five complete specimens and four ventral valves), two complete and one broken shell at GSC locality 56430A, and one almost complete shell from GSC locality C-4085. This species has been described from the Upper Car-

Table 21.—*Measurements (in millimeters) of* Phricodothyris asiatica *Chao from GSC locality 56430.*

GSC number	Length	Width	Thickness	Hingeline	Width/HL ratio
115662	22.1	22.5	14.2	11.1	2.0
115663	—	21.0	11.8	10.6	2.0
115664	14.0	14.3	9.9	6.7	2.1

→

Fig. 28.—Terebratuloids and retzioids. 28.1–28.20, *Beecheria* cf. *B. itaitubensis* (Derby, 1874), ventral, dorsal, lateral, and anterior views of a growth series of five specimens, GSC 115665–115669, respectively, × 1. 28.21–28.36, *Cranaena nassichuki* n. sp., ventral, dorsal, lateral, and anterior views of four specimens, including the holotype (28.21–28.24), GSC 115670–115673, respectively, × 3. 28.37, 28.38, *Beecheria* sp., ventral and dorsal views of a crushed specimen, GSC 115674, × 1.5. 28.39, 28.40, indeterminate terebratuloid, ventral and anterior views of a ventral valve, GSC 115675, × 1.5. 28.41, *Hustedia* sp., ventral valve, GSC 115676, × 3.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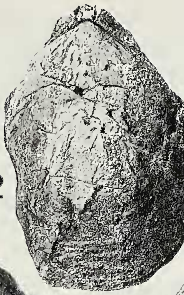
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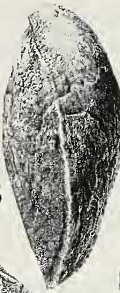
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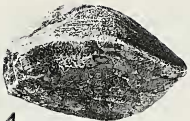
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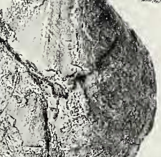
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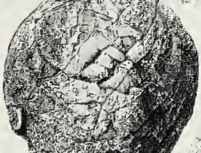
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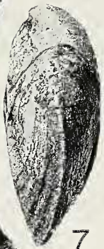
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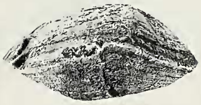
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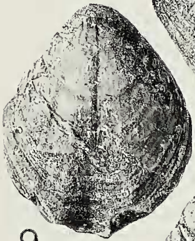
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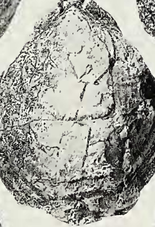
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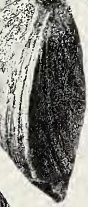
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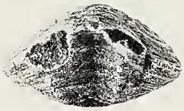
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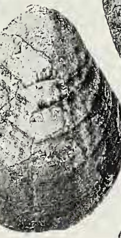
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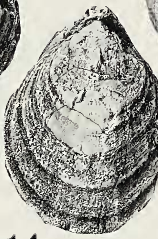
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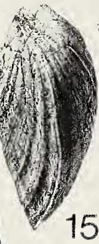
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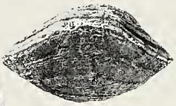
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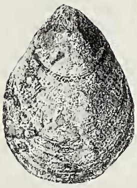
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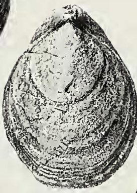
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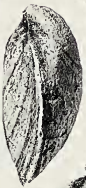
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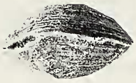
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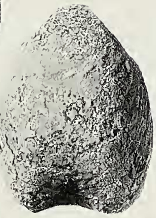
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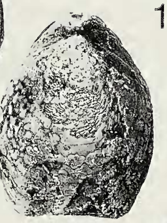
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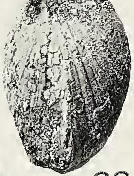
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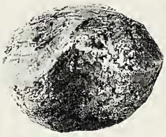
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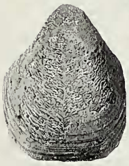
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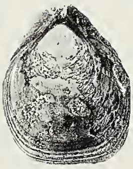
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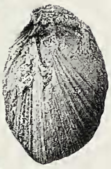
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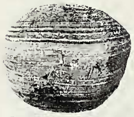
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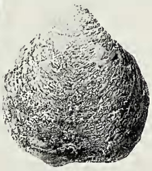
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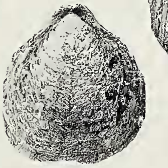
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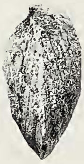
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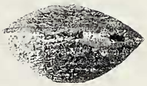
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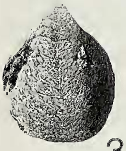
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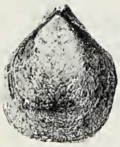
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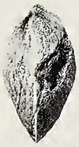
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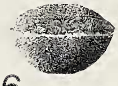
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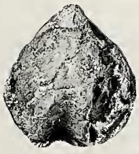
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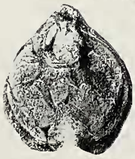
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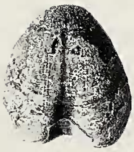
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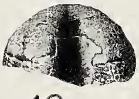
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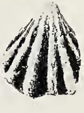
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Table 22.—*Measurements (in millimeters) of the types of* Cranaena nassichuki, *n. sp. from GSC locality 56430.*

GSC number	Length	Width	Thickness
115670	9.1	7.1	5.8
115671	7.0	5.7	4.9
115672	7.1	6.5	3.5
115673	5.9	4.8	3.3

boniferous and Lower Permian of China, Malaysia, Transcaucasus, and the Ural Mountains.

Order Retziidina Boucot, Johnson, and Staton, 1965
Superfamily Retzioidea Waagen, 1883
Family Retziidae Waagen, 1883
Genus *Hustedia* Hall and Clarke, 1893
Hustedia sp.
(Fig. 28.41)

Comments.—A minute ventral valve of a clearly punctate retziid can be assigned to the genus *Hustedia* Hall and Clarke. It bears eight strong subangular costae. A rounded median interspace is present. This specimen falls within the range of morphological variation of several species.

Distribution.—GSC locality 56430 (one ventral valve).

Order Terebratulida Waagen, 1883
Suborder Terebrtatulidina Waagen, 1883
Superfamily Dielasmatoidea Schuchert, 1913
Family Cranaenidae Cloud, 1942
Genus *Cranaena* Hall and Clarke, 1893
Cranaena nassichuki, **new species**
(Fig. 28.21–28.36)

Holotype.—Figures 28.21–28.24, GSC 115670, from GSC locality 56430.

Paratypes.—Figures 28.25–28.36, three juveniles, GSC 115671–115673, all from GSC locality 56430.

Description.—Small for genus, subequally biconvex; outline rounded subpentagonal to guttate; lateral profile lenticular; anterior profile of large specimens subovate; fold lacking but well-developed sulcus present in anterior third of adult ventral valves; anterior commissure uniplicate in adult shells, rectimarginate in juveniles.

Ventral valve with moderately inflated and narrow umbonal region; lateral slopes evenly convex to lateral margins; sulcus originating well anterior to midlength, rounded, forming emargination in adults in ventral view; beak nearly straight in adults to suberect in juveniles; foramen rounded, epithyridid to mesothyridid; interior with pedicle collar and short dental plates.

Dorsal valve with narrow swollen umbonal region laterally delineated by concave flexures; lateral slopes less convex than those of opposite valve; dorsum well rounded posteriorly, becoming flattened or even slightly concave anteriorly; interior with posteriorly perforate undivided dorsally concave hingeplate; loop not observed.

Measurements.—See Table 22.

Diagnosis.—This species can be differentiated by its well-developed ventral sulcus and moderately narrow ventral umbonal region.

Comments.—Two specimens of this species were sectioned. Although coarsely recrystallized internally, enough internal details were gleaned from these specimens to suggest that this species is most likely a *Cranaena*, although the loop was not preserved in either specimen. *Cranaena* is rare above the Lower Carboniferous with species being described by Lane (1962) from the Lower Moscovian of Nevada, Czarniecki (1969) from the Gzhelian of Spitsbergen, and Kalashnikov (1980) from the Bashkirian of Novaya Zemlya and the Asselian of the northern Urals. None of these species is closely similar externally to this Hare Fiord species, all having somewhat broader ventral umbones and thicker profiles.

Distribution.—GSC locality 56430 (13 specimens, two sectioned).

Family Heterelasminidae Likharev, 1956

Genus *Beecheria* Hall and Clarke, 1893

Beecheria cf. *B. itaitubensis* (Derby, 1874)

(Fig. 28.1–28.20)

1874 *Terebratula itaitubensis* Derby, p. 1, pl. 2, fig. 1, 3, 8, 16; pl. 3, fig. 24; pl. 6, fig. 15.

Description.—Large, subequally biconvex, moderately compressed, much longer than wide; outline longitudinally guttate to rounded subquadrate; lateral and anterior profiles lenticular; maximum width varying from just in front of midlength to just posterior to it; venter flattened or with shallow sulcus; dorsum in anterior profile arched to evenly rounded; anterior commissure weakly uniplicate to rectimarginate; surfaces smooth except for irregularly spaced growth varices and faint fine growth lines.

Ventral valve with moderately elongated umbonal region; lateral slopes and venter evenly and moderately convex; sulcus, if present, very weak and shallow, confined to anterior half of valve; beak ridges rounded but well differentiated; beak nearly erect; foramen large, subovate, permesothyridid; deltidial plates not observed, obscured by beak; interior with strong short dental plates.

Dorsal valve moderately inflated, less convex than opposite valve, most convex posteriorly, with moderately to prominently arched dorsum in large specimens, more evenly convex in juveniles; lateral slopes gently convex; beak acute, small, obscured by ventral valve; interior with inner and outer hingeplates sessile and forming tent-like structures, fused medially with valve floor and forming false median septum, bearing crural bases at peaks.

Comments.—This species is similar in outline and size to *Beecheria itaitubensis* Derby from the Desmoinesian of the Amazon Basin, Brazil. Mendes (1957) illustrated a small specimen of this species with similar outline and appearance from the same general horizon and region as Derby's specimens.

Distribution.—GSC locality 60194 (36 specimens).

Beecheria sp.

(Fig. 28.37, 28.38)

Comments.—This small, crushed specimen bears the two tent-like structures on the floor of the dorsal valve that characterize the genus *Beecheria*. A narrow ventral umbonal region and strong foldsulcus preclude a close relationship with the species described above as *Beecheria* cf. *B. itaitubensis* (Derby). The modest size and strong foldsulcus of this specimen suggest similarity to *Beecheria daltonensis* Sutherland and Harlow, 1973, from Moscovian-age beds in New Mexico. Most illustrated specimens of the latter have a broader ventral umbonal region and a robust lateral profile, a feature not ascertainable in this crushed specimen.

Distribution.—A single, crushed specimen from GSC locality C-5202.

Indeterminate terebratuloid

(Fig. 28.39, 28.40)

Comments.—This disarticulated ventral valve is similar in size to the specimen described above as *Beecheria* sp. It has a well-developed sulcus like that specimen but the ventral umbo is broad and well rounded laterally. This specimen is not crushed but lacking a dorsal valve cannot be assigned to a genus.

Distribution.—A single ventral valve from GSC locality C-5202.

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Walter Nassichuk, Geological Survey of Canada, collected most of the specimens that form the basis of this report and we are grateful to him for his generous support of our efforts, for the loan of his collections, and a critique of this report. Stanislav S. Lazarev assisted us greatly with advice on the identification and classification of the productids. J. T. Dutro, Jr., R. B. Blodgett, and Norman Savage apprised us of and otherwise helped us with the faunas of southeastern Alaska. Bruce Wardlaw of the U. S. Geological Survey loaned us the Ladrones Limestone collections made by George H. Girty in 1918. To our anonymous reviewers we express profuse thanks for finding our mistakes in both expression and content.

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